

**Proceedings  
of  
International Bio-slurry Workshop and  
Study Tour  
Dhaka, Bangladesh  
10-13 November, 2008**



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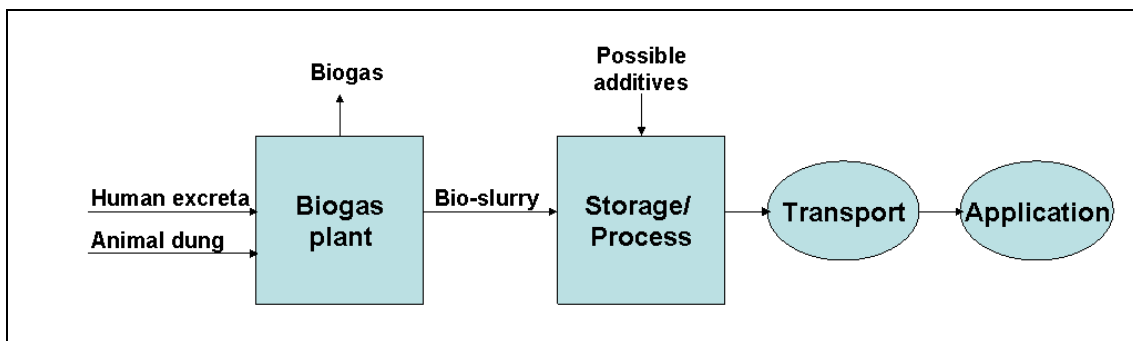
## 1. GENERAL

SNV Netherlands Development Organisation in association with National Domestic Biogas and Manure Program (NDBMP), Bangladesh organized a four-day International Bio-slurry Workshop and Study Tour in Bangladesh during 10-13 November, 2008. Fourteen participants from 6 countries of Asia and Africa participated in the workshop and study tour. This study tour proceeding is intended to bring the ideas and views of those attending the tour to a wider audience of bio-slurry practitioners. It is expected that this proceeding will contribute to the broader ongoing discussions about programs and activities that will facilitate the inclusion of effective management and use of bio-slurry in initiatives on promotion and development of biogas technology in different parts of the globe.

This proceeding includes (i) the summary of country report on the status of bio-slurry management and utilization, limitations and future plan (ii) Field visit experience and, (iii) Group discussions. As much as possible, the issues raised by the participants during different sessions have been presented in their own words.

## 2. BACKGROUND

Domestic biogas plants convert animal dung and human excreta at household level into small but precious amounts of combustible gas, known as ‘biogas’. This gas can be effectively used in simple gas stoves for cooking and in lamps for lighting. The other product of the process is known as ‘bio slurry’<sup>1</sup>.



The biogas/biodigester programs supported by SNV in Asia and Africa all have a bio-slurry extension component. The aim of this component is to maximize the revenues for a farmer on his investment by making optimal use of bio-slurry as organic fertilizer to enhance agricultural productivity or as food for fishpond and feed for animal.

As the return of the investment will increase, the market for bio-digesters especially among the resource poor farmers will increase as well.

<sup>1</sup> The term bio-slurry is used here for the residue that comes out of the biogas plant. Other terms sometimes used are just ‘slurry’, ‘effluent’, ‘bio-manure’, ‘sludge’, ‘organic fertiliser’ and ‘organic manure’.

Considering the importance of the best possible use of bio-slurry an international workshop on this topic was organized by SNV in September 2006 in Bangkok, Thailand.

To follow-up on this workshop, a study tour for bio-slurry experts working in SNV supported programs was organized in September 2007 in Nepal. It was decided to organize this kind of bio-slurry event comprising of workshop and field visit at least once in a year.

### **3. OBJECTIVES OF THE STUDY TOUR**

The overall objective of the study tour is:

Enhance the exchange of experiences and knowledge among bio-slurry extension officers in SNV supported programs.

Specific objectives are:

- Exchange on bio-slurry quality, management and utilization approaches and methods;
- Identification of most successful extension methods/vehicles in the different programs;
- Optimisation of bio-slurry extension activity plans.

### **4. SCHEDULE**

The workshop and study tour was conducted for four days. The program consisted of three main sessions – country presentations & discussions, field visits and group exercise. The detailed schedule has been given in Annex-1.

### **5. PARTICIPANTS**

Sixteen participants from Bangladesh, Cambodia, Lao PDR, Nepal, Vietnam, Rwanda took part in the workshop. The details of the participants have been given in Annex-2.

### **6. PROCESS AND OUTCOME**

#### **6.1 Opening Remarks**

Following the formal registration of participants, a brief opening ceremony was organized which started by the brief personal introduction of the participants. After that Dr. M. Fokhrul Islam, Bio-Manure Management Advisor, SNV Bangladesh welcomed the participants in the workshop and he gave a presentation on overview of prospect, potentialities and challenges of use of bio-slurry in agriculture. Mr. Sundar Bajgain, Senior Biogas Advisor, SNV Bangladesh in his opening remarks, mentioned the importance of biogas technology and management and use of bio-slurry in rural development. Special guest Mr. Abdul Mazid Biswas, Director General of the Department of Agricultural Extension emphasized the use of bio-slurry for maintaining

soil fertility and increasing crop production. Chief Guest Mr. Harun-ur-Rashid, Executive Chairman, Bangladesh Agricultural Research Council and Director General of Bangladesh Agricultural Research Institute emphasized to determine more precisely the manural value and heavy metal concentration of bio-slurry from different substrates used in biogas plant. He also expressed to find out efficient method and techniques for storage and transportation of bio-slurry. He hoped that the better management of bio-slurry would positively contribute to maintaining the soil heath and to increasing the agriculture production and thereby in improving quality of life of people. He strongly pointed out the necessity of sharing experiences from each other participants from Asian and African countries. Opening session chairperson Mr. Formanul Islam, Director (Legal) and Company Secretary of IDCOL emphasized the highest possible use of bio-slurry in line of food security policy of the government of Bangladesh. He reminded the outcome and action plan made in the previous workshops and expected that the present workshop would assess the status of progress i.e. where we are and how far we have to go.

At the end of the opening ceremony, Mr. Nazmul Haque Faisal, Senior Program Manager, NDBMP, Bangladesh gave a vote of thanks and wished the success of the workshop.

## **6.2 Introduction of the Workshop**

The workshop commenced with a brief introduction from Dr. M. Fokhrul Islam, Bio-Manure Management Advisor, SNV Bangladesh and coordinator of the workshop on the objectives, contents, expected outcome of the workshop, some practical issues related to logistic arrangements.

## **6.3 Technical Session I**

### **6.3.1 Presentation of Country Report**

Session chairman Professor Dr. M. Jahiruddin, Department of Soil Science, Bangladesh Agricultural University, Mymensingh gave a brief on organizational aspects of the session was followed by country reports on research and extension of bio-slurry in Vietnam, Lao PDR, Rwanda, Nepal, Cambodia and Bangladesh.

#### **Country Report of Vietnam**

##### **Presentation Highlights**

##### **General**

Presenting her paper entitled, '**Bio-slurry Activities in Vietnam**', Ms. Le Thi Xuan Thu highlighted on various research activities conducted in Vietnam in the past and corresponding outcomes. She also described the current status of use of bio-slurry in

Vietnam including challenges and opportunities and a case study on use of bio-slurry in tea production.

In Vietnam about 74% population lives on agriculture that share 20.36% in GDP.

Biogas project in Vietnam is implemented in two phases.

Phase I 2003-06 18,000 plants installed in 12 provinces

Phase II 2007-11 29,000 plants installed (2007-14,000 & 2008- 15,000)

The use of bio-slurry by the households increased from 41% in phase I to 62% in 2008.

### **Bio-slurry Research**

Research on bio-slurry is done by research institutes and universities of Vietnam. The following three studies were done:

#### 1. Assess quality of bio-slurry

Research focuses on determination of concentration of primary plant nutrients (N, P and K) and heavy metals (Cd, Pb, As, Hg) in solid and liquid bio-slurry and loss of N after different days of storage.

- Both the total content and available content of N, P, and K in bio-slurry are relatively higher than those of FYM/manure.
- The amount of loss of N increases with increase of storage time.
- The content of heavy metal (Cd, Pb, As, Hg) in bio-slurry is within allowable standards of Vietnam.
- Bio-slurry contains cellulose decomposing bacteria, yeast and molds.
- Bio-slurry can be used as pig feed @ 1-2 litre per kg of basal diet and that increase the meat production without any negative effect on health and quality of pig meat.

A study was conducted at nine households having biogas digesters which constructed strictly following the Project model designs in two communes of Thanh Xuan and Bac Phu, Soc Son district, Hanoi. Cow dung, pig dung and mixture of cow dung and pig dung were used to feed into digesters. Samples of liquid bio-slurry were taken at two stages: stage 1 when dilution ratio of dung and water = 1 / 2.1 – 1 / 2.6 was applied and; stage 2 was 45 days after stage 1 and dilution ratio of dung and water was adjusted to reduce to 1 / 1 – 1 / 2.

The research shows that the dilution ratio of dung and water = 1 / 1- 1 / 2 should be applied for diluting animal dung. Liquid bio-slurry can be consider as potent fertilizer as it contains sufficient nutrient elements as well as trace elements while having no disease-cause microorganisms like cholera or typhoid . It contains less parasitic eggs thus can be used for watering fertilizer or as foliar fertilizers for all kinds of crop.

When used as watering fertilizer, liquid bio-slurry from cow dung, pig dung and mixture cow dung and pig dung should be added with water 3.8-4 times (eg. 1 bio-slurry and 3 water), 3 times (eg. 1 liquid bio-slurry and 2 water) and, 3 times (eg. 1 liquid bio-slurry and 2 water) respectively

## 2. Effect of different levels of liquid bio-slurry in diets on production performance, meat quality of F2 crossbred fattening pigs

An on-farm feeding trial was conducted with a total of 36 F2 crossbred fattening pigs (Mong cai local sow x Yorkshire boar) of 21 kg average initial weight. The pigs were divided into 12 pens (2 males and 1 females in each pen) consist of 4 treatments with 3 replications following a completely randomized design. Pigs in treatment 1 were fed a basal diet meet requirements consisting of maize meal, rice bran, soybean meal, cassava meal and fish meal. Pigs in treatment 2, 3 and 4 were fed the basal diet mixing with liquid biodigester effluent at 3 different levels as 1, 2, 3 liter/kg of feed, respectively. During 20-80 kg period, the pigs on treatments 2, 3 and 4 fed diets consisted of the effluent had significantly higher feed intake and average daily gain than on the treatment 1 (basal treatment), however the feed conversion ratio between treatments were non-significantly different. There weren't any symptoms of the respiratory diseases and digestive diseases found in all 3 treatments fed the effluent. The present of the biodigester effluent in diets did not effect on meat quality, including smell and taste as well as the deposit of heavy elements in lean meat.

## 3. Study on the usage and processing of biogas sump wastes as organic fertilizers for paddy rice and peanut on degraded soils.

- For convenient use solid effluent can be preliminarily treated with on-farm organic materials with the mixing ratio: 100 kg of solid effluent + 6 kg of dry straw rice or 6 kg of dry weed. The treated solid effluent had the same positive effects on growth, development and yields of summer rice as manure did.
- Application of liquid effluent as basal dressing for rice had the similar effects on growth, development and yield of rice as inorganic fertilizers. It can save 44-174 kg urea/ha; 8-30 kg super phosphate/ha.
- Use of liquid effluent as top dressing for peanut gave better growth and yield compared with application of inorganic fertilizers. When replacing all inorganic fertilizers by liquid bio-slurry as 2 top dressings the yield of peanut was found 8.5% higher than that of inorganic fertilizer.

## **Bio-slurry Extension**

### **Activity 1. Development of Extension Materials**

From 2003 up to now, a number of materials have been developed and delivered among biogas actor and biogas households, as follows:

- Leaflet on biogas technology in which bio-slurry extension is a part;
- Posters on biogas technology in which bio-slurry extension is a part,
- User handbook in which, bio-slurry and its extension are mentioned in a chapter,
- A film on bio-slurry and extension namely “Dong for Dung”,
- Training manuals for technicians and masons have been developed in which, bio-slurry and extension is a module.

## Activity 2. Training

Efficient bio-slurry utilization in plantation, animal production and aquaculture activities contribute to optimization of biogas technology, to increase income of people and reduce payback time. It is perceived as one of the priorities in the Biogas Project Phase II.

One of the conclusions that can be drawn from the Biogas Users Survey and quality control activity carried out by BPD is that bio-slurry is not widely used or even channeled away into sewer systems. This is mainly due to lack of knowledge and poor awareness of the benefits.

- In Phase I and 2006, a training course on **operation of biogas plant and use of bio-slurry in agriculture and aquaculture production** was organized for users. Farmers were also provided with knowledge and experiences on what quantity of bio-slurry to be applied for specific purposes as well as how to combine bio-slurry and chemical fertilizer in cultivation.
- In 2007, a training course was organized addressing general knowledge on construction of digester, how to operate and maintain digester properly and how to use bio-slurry efficiently.
- From 2003 to 2007, about 41,000 households (?? **Upto 2007 32,000 plants were constructed- Ms. Le Thi Xuan Thu please comment and correct**) were provided with training on use of bio-slurry.
- Training was provided for 300 technicians and 600 masons

## Activity 3. Demonstration

There were 27 demo plots were established in 2007 in provinces of Bac Ninh, Binh Dinh, Hanoi, Ha Nam, Nghe An and Phu Tho<sup>2</sup>.

**Table 1. Demonstrations conducted in 2007**

Province	# of demo	Bio-slurry used for			
		Crop	Fish pond	For pig	For mushroom cultivation
Bac Ninh	10	10 (tomato, cabbage & soybean)			
Binh Dinh	4	2 (bitter melon and elephant)	1		1
Hanoi	4	4			
Ha Nam	5	3	2		
Nghe An	3	2	1		
Phu Tho	1	1			
<b>Total</b>	<b>26</b>	<b>21</b>	<b>4</b>		<b>1</b>

<sup>2</sup> Hai Phong, Hai Duong, Hoa Binh, Tra Vinh and Dong Nai planned to set up demo plot but they have not yet sent final reports. Son La did not build demo plot in the last minute.

- In bitter melon plot, both solid residue and digested effluent (dilute with water at ratio of 1:1) and 70% chemical fertilizer. The practice helped increase yield up 119%, decrease pest 20% and increase profit 31 times in the comparison of control.
- In the mushroom plot, digested effluent was used to water straw and supply nutrients for mushroom growth. With 10% digested effluent used with water, the yield increased 15% in comparison with control.
- Use of bio-slurry along with reduced amount of chemical fertilizer in jasmine flower in Hanoi increased 13-74% profit compared to use of only chemical fertilizer. Use of bio-slurry in daisy flower and carnation flower in Hanam replaced 70% of chemical fertilizer resulted in the growth time reduced 5-7 days while the lifetime of flower increased 3-4 days. Some of pests also slightly decreased.
- The use of bio-slurry in 2 demonstrations with cabbage reduced the use of chemical fertilizer and pesticide while cost saving is 8%, yield increased 11-22%, crop duration decreased 5-7 days and profit increased 14%.
- Use of bio-slurry in fishpond demonstrations in Binh Dinh, Ha nam and Nghe resulted that the basal diet reduced 15.5%, yield increased 5-25%. Besides, the floating head phenomenon and fish death was reduced in the comparison of fishpond applied fresh manure in Nghe An.

### **Bio-slurry Management and Utilization at Farm level**

- About 56.8% of biogas plant owners use bio-slurry, mainly for vegetable, garden and fishpond (**Based upon QC by BPD**). It widely varied in provinces.
- Among 75% of bio-slurry users and 25% non-users 91% know about benefit of use of bio-slurry as fertilizer, 48% know about the benefit of fertilizer and pesticide cost reduction; 43% know about benefit for fishpond and 33% know about benefit for animal production. Among bio-slurry users, 93% use bio-slurry as fertilizer for crops, 7% use bio-slurry for fishpond, 22% use for composting while only 1.6% use for animal production (**Biogas user survey – 2006**).
- According to the data-base of BP out of biogas users there is nearly 62 % using bio-slurry. Out of them 88% use bio-slurry for watering vegetable and 7% use bio-slurry for fish-pond.
- Farmers use bio-slurry or slurry scum as organic fertilizer for industrial crops like pepper, cashew, tea, coffee and fish-pond.

### **Limitation**

In relation to organization and manpower

- Still there is a lacking of a domestic network for organizations, institutes and individuals working on bio-slurry and bio-slurry extension. In Vietnam, biogas technology currently is a small subject in the curriculum of some university. However, there is lack of deep understanding on this issue.



- In biogas component at national level there is only one staff working on bio-slurry. She is responsible for creating networking, coordinating bio-slurry activities under the program and cooperating with national institutes and university in doing researches on this issue.
- A number of provincial/district technicians do not have any knowledge on bio-slurry as they have background of construction or other sector.

In relation to technology – storage, drying, transportation, use etc.

- The bio-slurry practice needs more labor than traditional manure.
- Transport of liquid bio-slurry to distant field.
- Loss of nitrogen of bio-slurry because of not properly handle and use.

Main restrictions to widespread use of bio-slurry in Vietnam are:

- Bio-slurry is mainly in liquid form making it difficult to transport to the field where the slurry pit is usually far away from the fields.
- Awareness of farmers/users: Despite the fact that a lot of commune promotion workshops have been carried out, the awareness of biogas users is still limited.
- Lack of labor: Some households prefer using chemical fertilizers because using bio-slurry or composting bio-slurry takes time and therefore opportunity costs for the labor force. Traditional habits in farming activity: there are some restriction when introducing the composting method in southern provinces where people do not have the habit of making compost fertilizer from on-farm residues and using bio-slurry.

### **Lesson learned and Opportunity**

One of the conclusions that can be drawn from the Biogas Users Survey and quality control activity carried out by BPD is that bio-slurry is not widely used or even discharge away into sewage systems. This is mainly due to lack of knowledge and poor awareness of the benefits. Setting up demo plots of bio-slurry use helps encourage and guide farmers apply this by-product. Households who selected to setup demo plots are willing to share their experiences with other farmers.

From the potential of bio-slurry sources, thousands of tons of organic fertilizer may be produced by farmers and used effectively for growing vegetables and tea production. The application of organic fertilizer could help farmers on reducing poverty themselves and protect the environment. The introduction of the current technology to farmers is an interesting issue that not only encourages them on application of biogas technology but also solves a strategic plan on organic agricultural production such as bio-safety rice, vegetable, tea etc. which could also solves one of the biggest challenges for farmers on improving their agricultural products effectively when join WTO.

There is an opportunity of commercialization of bio-slurry product by collecting, processing and selling it as organic fertilizer to farmers.

## **Future action plan**

- Present research and demonstration activities will be continued.
- More promotional and education document will be developed.
- Stakeholder meetings will be organized
- An advisory committee can be set up for strengthening research & demonstration

## **Country Report of Lao PDR**

### **Introduction and Background**

The Lao Biogas Pilot Program (BPP) was established in November 2006 with the signing of a Memorandum of Understanding (MOU) between SNV (Netherlands Development Organisation) and the Department of Livestock and Fisheries (DLF) of the Ministry of Agriculture and Forestry. In early 2007 the BPP project office was opened at DLF with 8 team members, including a part-time Project Director from DLF and two SNV advisors.

BPP has not yet fully focused on bio-slurry extension activities, but the main actions and plans are as follows:

- The BPP Director and Promotions and Training Officer attended the Bio-slurry Study Tour held in Nepal in November 2007;
- BPP held discussions with the Department of Agriculture regarding potential bio-slurry demonstration and training activities, and visited a potential site, but resource constraints has stalled further action so far;
- BPP has commissioned an expert foreign consultant to conduct a study into the potential for commercialization of bio-slurry by BPP's customers. This started in September and the results will be available by November 2008;
- BPP plans to establish some basic crop trials in cooperation with an organic farming project under the Department of Agriculture, and based on findings and laboratory analysis from the marketing study;
- A Bio-slurry Officer has been assigned to work with BPP full time by the Department of Livestock and Fisheries – his tasks will include implementing the bio-slurry activities;

### **How farmers are presently using their bio-slurry**

Farmers understanding and knowledge of using bio-slurry is limited since the technology of bio-slurry extension is new for them. But most of the farmers who have biogas plant doing similar to what they had been practiced with raw animal dung directly to their farms. According to the team monitoring the farmers found that most of farmers are practicing of using bio-slurry as followings:

- Farmers usually keep bio-slurry in the tanks and from the tanks they use in the field directly. Many farmers drain out slurry to the surrounding areas.

- Mix husks, saw dust, leaves and grass with the bio-slurry and leave it to digest and dry it, after that put it in the bags and keep it under shade.
- Some households even do not use it, they just leave it and make dirty around the areas.
- Some households use bio-slurry to mix with dirt and nursing the nurseries.
- Some households use bio-slurry to mix with water and watering their growing crops, plants, trees, fruit trees, garden, flower vases and rice farms.
- Some farmers use bio-slurry in seed bed for growing vegetables, trees and fruit trees.

The Lao BPP Biogas User Survey reported the following findings regarding use of bio-slurry:

- About 75% of the users were using bio-slurry in one or other ways. The reasons for not using were the lack of agricultural land or crops to use (10%) and bio-slurry not-coming out of the biogas digester (15%). The users who did not use the slurry drain it directly to surrounding areas and watercourses.
- Though the users are yet to realize the effects of bio-slurry, still, 85% of the users who used slurry on farm reported that it is of high nutrient value than the farmyard manure and the remaining 15% reported that the nutrient value of bio-slurry is somewhat same as the FYM. The use according to them were: use as organic manure without composting (70%), use as manure with composting (15%) and use wet slurry directly to the crops (15%). Though the users expressed their views that the production of crop has increased after the use of bio-slurry, they could not exactly quantify the increment.

### **Limitations**

Farmers have lack of knowledge and skills regarding to new technique of using bio-slurry. Some households were lacking of labour for proper management and utilization of bio-slurry.

Other issues are lack of knowledge on application techniques for specific types of crops and soil conditions. Awareness and skills are lacking for commercializing of excess bio-slurry.

### **Future plan**

The main bio-slurry activities planned by BPP are:

- Developing a more detailed bio-slurry strategy with the help of a mission by Dr. Fokhrul Islam to Laos (hopefully);
- Dissemination of the results of the bio-slurry marketing study, in the form of business plans and possibly training and documentation on how to package and sell bio-slurry

- Establishment of basic crop trials with organic farmers in Vientiane province to demonstrate the effectiveness of various types and techniques of bio-slurry applications
- Using the new Bio-slurry officer to actively promote improved bio-slurry extension activities among BPP's customers.
- To do this effectively, the BPP will also seek for the cooperation with other organization that has been produced organic fertilizer to assist local government counterpart, this is to make sure that he is capable enough to carry on this activity sustainable.

## **Conclusion and Recommendation**

BPP is very keen to start the activity of bio-slurry extension after having the final report from external consultant. Technical Assistant from Bio-slurry Advisor of SNV is needed for government counterpart in order to build the capacity of local government counterpart. It is recommended by the DLF to the BPP to focus on bio-slurry activity as soon as possible in order to encourage farmers to install biogas plants and use of bio-slurry more effectively.

- Activity is minimum
- Farmers' knowledge about biogas and bio-slurry technology is highly limited.
- Bio-slurry extension activities like development of extension materials, training, demonstration and backup research need to be carried out.

## **Country Report of Rwanda**

### **Introduction**

#### General Feature of Agriculture

Rwanda the 'land of a thousand hills' is a hilly and evergreen land-locked country located in East Africa, has an area of 26,338 km<sup>2</sup> with an estimated population of 8.2 millions inhabitants (NCS, 2003). Arable land is estimated at 1.3 million hectares. Rainfed agriculture is practiced in the whole country with only 9000 ha irrigated land mainly for rice cultivation (FAOSTAT, 2005). About 60-70% of arable land is cultivated, this means that another 30-40 % of the land (420 000 to 560 000 Ha) more could be cultivated.

A high altitude 950 to 4519 m AMSL gives Rwanda a mild and pleasant climate with an annual average temperature of 22<sup>0</sup> C and generally 22-27°C during the day and 16-21°C at night. Average annual rainfall in the whole of Rwanda is 1111mm, but we can note variations from 700 mm in the North-West to 1600 mm/year in the South-West. A regular alternation of dry and rainy seasons allows two cropping seasons per year. Bimodal rainfall pattern but excess rainfall and shift in the rainfall pattern cause productivity reduction and frequent famines. The average size of a family farm is 0.76 ha.

Agriculture has played a distinctive role in Rwandan culture and history and contributes a share of more than 40% GDP to the total national GDP. The major crops are sorghum; eleusine, corn (maize), potatoes, sweet potatoes, cassava (manioc), dry beans, and plantains are the major food crops. While coffee, tea and pyrethrum are the dominating cash crops. Tea is the leading crop in export earnings for Rwanda . In 2002, export earnings from tea were US\$ 18 million (15 000 tons dried tea). Coffee production, second to tea, featured a decrease by 37% between 1990 and 2002; owing to declining world market prices, liberalization of coffee policies that resulted into fewer Rwandan households growing coffee. In Rwanda only 5% farmers use chemical fertilizer due to lack of adequate knowledge in fertilizer use as well as the prohibitive cost of obtaining it, (Jones 2007). Organic fertilizer remains the most commonly used fertilizer at household level, while the organic fertilizer is mostly used in plantation crops like tea and coffee, and in potatoes production in the North of the country (IFPRI, 2007).

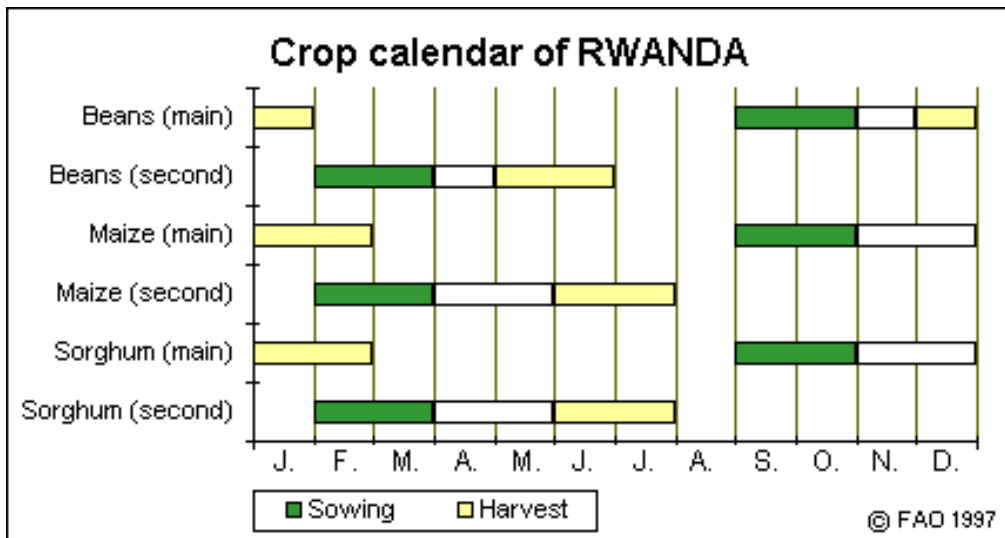


Fig.1 Major Crop Season in Rwanda

### Biogas Program in Rwanda

Biogas technology was introduced in Rwanda in the 70s, but the large scale implementation started with Institutional biogas systems introduced by the Kigali Institute of Science and Technology (KIST) in 2000.

National Domestic Biogas Program (NDBP) under the Ministry of Infrastructure in Rwanda started in May 2007 by a pilot project which paved the way to the implementation phase 2008-2011 started in January 2008 with institutional setup and field preparations while the first bio-digesters constructions in this phase started in June 2008

In the period of pilot project 101 digesters were constructed in 4 districts. At present more than 300 new contracts for construction of digesters were signed among them 50 digesters were completed and 1042 more farmers willing to construct biogas digester.

### **Bio-slurry Component of NDBP**

Bio-slurry is an integrated component of NDBP and on each digester installed it is compulsory to connect two standard compost pits of 1.5 m<sup>3</sup> each with a thatch covering roof.

### **Status of Bio-slurry Activities**

The ongoing activities in the area of bio-slurry management and utilization includes installation of compost pits and training of farmers in proper application of bio-slurry in gardens both in liquid and solid forms.

#### Research

The research component of bio-slurry in NDBP has started with establishment of research partnership with The Higher Institute of Agriculture and Animal Husbandry (ISAE) by providing them with two household size bio-digester units that will serve for research purpose in addition, Terms of Reference (ToR) for bio-slurry research activities were drafted for ISAE to implement a research project on application and adaptation of bio-slurry use in NDBP District of operations. A team of ISAE scientists comprised of a biogas specialist, a soil scientist, and an agronomist are working on bio slurry research proposal to fit the NDBP requirements. Starting with agricultural season of 2008 -2009, initial trials will be conducted in ISAE farms and in farmers' fields in the country.

#### Bio-slurry Extension

##### Activity 1: Development of Extension Materials

The slurry use is incorporated in various training and users' manual developed by NDBP for use by technicians and farmers respectively and a specific manual for bio-slurry use will be produced.

Bio-slurry use is highlighted in farmers' sensitization meetings and will be covered in planned media coverage on Radio, TV and Newspaper for information access by farmers countrywide.

##### Activity 2: Training

Bio-slurry application is taken into consideration in all biogas training organized by NDBP for users and technicians.

Farmers have applied bio-slurry management and have realized its impact in increasing their crop yield.

Training modules in local language on bio slurry management and utilization have to be developed in accordance with research findings. Demonstration fields in two campuses of ISAE farms in two different agro ecological zones will help to train farmers on benefits of using bio-slurry as organic fertilizer.

Trainings on bio slurry use will be provided to NDBP field technicians so as to extend the skills to private companies and to farmers in user's trainings.

### Activity 3: Demonstration

Demonstration plots for various crops will be installed at both ISAE campuses which will help the learning process both to trained agricultural professionals as well as farmers during their field visits to ISAE farms. In this demonstration plots varying doses and slurry qualities will be applied during the research stages and best practices will be maintained to show case the benefits of bio slurry use.

### **Bio-slurry Management and Utilization at Farm level**

At present about 100 farmers have started using bio-slurry in their farms as follows:

- Bio-slurry is applied as liquid form to gardens around the household
- Bio-slurry is mixed with other agricultural residues in a series of compost pits and transported to farms near or far from household
- Bio-slurry is sold as liquid or solid forms by farmers living in semi urban areas or with limited lands for generation of resources

### **Limitation**

In relation to organization and manpower

The major limitation in management and utilization of bio-slurry is linked to the technical capacity of technicians.

In relation to technology – storage, drying, transportation, use etc.

The research component is in its infancy so there are not yet proven recommendations for the different crops and the different soils and agro ecological zones in the country. The bio slurry technology is yet to be well understood by farmers which implies a great deal of training to be done for all the farmers working with the NDBP

In relation to method(s) and technique(s) used for training and demonstrations

Training of farmers in the use of bio-slurry is still limited to demonstrations carried out with the households using biogas and it is limited only to the actual application and not yet extended to the improved ways of application that would result from research and development activities such as those to be undertaken by ISAE.

### **Lesson learned and Opportunity**

Farmers are now using bio-slurry in kitchen gardens that are being promoted country wide and can see the crop yield increasing and those who are not having enough land to cultivate have introduced a business of selling bio-slurry this has become one way of recovering their investment and generating income.

In Rwanda the use of compost is common thus introducing an advanced composting system will be easily accepted by the farmers.

### **Future plan**

In collaboration with researchers and local technicians' in-charge of Agriculture and Livestock, the Program will focus on standardization of the slurry composting pits and slurry application procedures, ensuring effective use of bio-slurry and monitoring of the impact of bio-slurry compared to other fertilizer in the local conditions.

Therefore it will be important to reinforce the bio-slurry research component to obtain effective recommendations for farmers in various agro ecological zones of the country and give proper recommendations for various crops taken along the agricultural year.

### **Conclusion and Recommendation**

The generation and application of bio-slurry has been one of the most important promotion tools in the development of a biogas sector in Rwanda

- NDBP so far constructed 151 digesters
- Bio-slurry activities are in the beginning stage. Research, training and demonstration activities yet to be started.
- Farmers are using slurry in kitchen garden only. It should be extended to the major crops. Only 5% farmers are using chemical fertilizers.
- Efficient training for NDBP field technicians and farmers is needed.
- A training manual on bio-slurry management and utilization should be developed urgently.



## Country Report of Nepal

### Introduction

Nepal is a small landlocked mountainous country situated between two giant Asian nations, China and India. The country occupying a total area of 147,181 km<sup>2</sup> sub-divided into five physiographic regions running south to north: they are, Terai, Siwaliks, Middle Mountains- also often referred as middle hills or mid hills in Nepal, High Mountains, and the High Himalayas.

There is a wide variation in climate ranging from tropical to arctic. The High Himalayan region is always below freezing point whereas the Terai and the low valleys are always warm. In Terai, temperature may go as high as 40<sup>0</sup> C in the hottest summer months. January is the coldest and June and July are the hottest months. Precipitation varies between 1,000 and 4,000 mm, with an annual average of 1,814 mm. More than 75% of the rainfall occurs during the monsoon season between June and September.

The cultivated area of Nepal is three million ha (approximately 21% of total area), of which about 11% falls under the Mountain region and 40 and 49% in the Hills and *Terai*, respectively. These regions accommodate 7.3, 44.3, and 47% of the population respectively.

### Nepalese Agriculture Sector in General

Nepal is predominantly an agrarian country. Of the total economically active population, 65.7% are involved in agriculture (CBS, 2002). Moreover, it is the mainstay of national economy as this sector contributes the largest share (38.81%) to the GDP (CBS, 2004).

Major crops grown are:

Cereals - Rice, Wheat, Maize, Finger millet, Buck wheat etc.

Vegetables - Potato, Tomato, Cabbage, Cauliflower, Beans, Peas, Okra, Pointed gourd, Leafy vegetables etc.

Spices - Ginger, turmeric, Cardamom, Onion, Chilly,

Oilseed crops - Mustard, Sunflower, Sarsoon

Industrial crops - Sugarcane, Tobacco, Jute, Tea, Coffee

Legumes - Lentil, Black gram, Red gram, Pigeon pea, Cowpea

Fruits - Mango, Banana, Orange, Sweet orange, Apple, Litchi, Pea, Pineapple, Jackfruit

Major cropping patterns followed in low land and up land field are given below:

<i>Low land</i>	<i>Up land</i>
Rice - Wheat - Fallow	Maize - Finger millet
Rice - Potato - Rice	Maize - Legumes
Rice - Vegetables - Vegetables	Maize - Vegetables
Rice - Legumes - Fallow	Vegetables - Vegetables
Rice - Fallow - Rice	Potato- Fallow

## **Farmers' Practices of Soil fertility management and Use of Fertilizers**

Farmers of mid hills of Nepal, since time immemorial, have been adopting a number of soil fertility management practices to manage their soils to sustain crop production. Some of such indigenous practices include terracing, slicing the bond and the walls of the terrace riser, in-situ manuring, green manuring, directing the fresh floods into the field, use of farmyard manure, compost, oil-cake, use of legume as a sole crop or as a mixed crops, crop rotation and mulching. Farm yard manure (FYM) and compost are by far the most important soil additives used by Nepalese farmers to manage fertility. FYM is made up of animal manures, forest litter, agricultural and household waste, including ash from cooking fires. Compost, on the other hand, is prepared using forest litter, green plant parts and plant residues and stubbles and a starter.

The use of chemical fertilizers has also been evolved as an important source of direct supply of major plant nutrients in the soil system over the years. The aggregate fertilizers consumption in Nepal during the fiscal year 2006/2007 was 99,848 Metric ton (Ministry of Agriculture and Cooperatives, 2007). The current rate of chemical fertilizer application is 32 kg nutrient per hectare.

### **Biogas Program**

Biogas plants established in 1975 with Government support and strengthened in 1992 onwards with SNV support

As of July-15 2008, 186,426 biogas plants have been installed. 72 Biogas Companies having around 180 branch offices in different parts of the country and 16 biogas appliances manufacturing workshop are involved in biogas program.

### **Bio-slurry Component of Biogas Program**

Different phases of Slurry Extension Programs were implemented at different periods by Biogas Support Program (BSP) under the framework of SNV/N and AEPC. They are as follows:

- Slurry Extension Pilot Program (SEPP): Implemented by SNV/BSP from November 1995 to July 1996.
- Slurry Extension Program-I (SEP or SEP-I): Implemented by SNV/BSP from February 1, 1997 to July 1999.
- Slurry Extension Program-II (SEP-II): Implemented by AEPC from September, 1998 to September 2000.

The bio-slurry program is under the Promotion and Training Unit of BSP-Nepal.

### **Status of Bio-slurry Activities**

#### **Research**

*Plan:* Tea is main cash crop grown by small farmers of eastern hilly districts of Nepal. It is popular in international markets and is good source of earning the foreign currency.

But because of the present trend of chemical based production, the tea growers of the region are facing acute market problems. Without organic it could not meet the international standards. In light of this fact, BSP-Nepal in collaboration with TEASEC (Tea Sector Service Centre, a NGO working for the tea grower specially the small farmers for organic tea production) has plan to conduct applied research for use of bio-slurry in bio-composting in organic tea farm in 2007/08.

*Implementation:* The site and tea farmer was selected by the TEASEC. A joint team of BSP-Nepal and TEASEC were visited to the sites for the interaction of the tea farmers and finalization. The newly 6 cubic meter biogas plant was constructed. One slurry pit (2 feet diameter) was constructed near the overflow of outlet to collect the bio-slurry. Three compost pits were digs from 1-1.5 meter away from outlet tank. The bottom and 15 cm height of the wall from the bottom of the pits was cemented to prevent leaching. The size of the pits was as per the recommendation. Shade over the pits was build for protection of sunlight. The bioas users were trained about the procedure of mixing the organic matter, bio-slurry application, turning etc. Technical personnel of TEASEC and BSP-Nepal have regularly monitored the activity. The locally available organic matter was used for the composting. For the better decomposition the compost was turned three times in five weeks interval. After proper composting the sample were taken according to the sampling standard for the analysis. The locally available composting organic matter was also analyzed to know the nutritive value.

*Results:*

The table below depicts the physico-chemical properties of animal dung, bio-slurry as well as the compost prepared by using bio-slurry as the starter for composting.

Table 2: Physico-chemical analysis of bio-slurry, slurry compost and farm yard manure.

Material	TS	Total N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Organic carbon	C/N ratio	B	Zn	Fe	Mn	Cu
	(%)						ppm				
Fresh dung	17.9	1.0	0.4	0.7	33.6	36.9	-	-	-	-	-
Urine	3.3	10.6	0.07	2.4	67.5	8.3	-	-	-	-	-
Bio-slurry	7.6	1.2	0.6	1.4	33.0	29.1	-	-	-	-	-
Slurry compost	35.2	1.6	1.2	0.9	37.8	23.5	93	0.0081	1.1	0.1	.002
Farm Yard Manure	21.6	1.0	1.3	0.7	47.0	46.2	-	-	-	-	-

Table 3: Pathogen analysis in the bio-slurry and bio-slurry compost

Pathogen	Bio-slurry	Bio-slurry compost
<i>Ancylostoma duodenale</i> (hook worm)	negative	negative
<i>Enterobius vermicularis</i> (pin/thread worm)	negative	negative
<i>Giardia lamblia</i>	positive	negative

Table 4: Nutrient content of the locally available organic materials used for composting.

Type of OM (Nepali name)	Total N %	P <sub>2</sub> O <sub>5</sub> %	K <sub>2</sub> O %
Dhotisara	2.8	1.8	3.4
Titeiati	3.6	3.7	0.2
Thotne	2.4	1.5	2.3
Angari	1.5	0.5	0.6
Unnu	2.7	1.5	3.3
Banmara	1.4	1.0	0.2
Bamboo	1.9	1.8	0.3

The results revealed that animal urine contains very high total nitrogen (10.6%) indicating the urgency of the need to put extra efforts to properly utilize this valuable animal by-product. The total nitrogen content in slurry compost prepared by using bio-slurry as the starter is higher than that of bio-slurry. This is because of the organic materials used for composting containing higher nitrogen (table 4). Bio-slurry compost also contains micro nutrients.

Important human health related pathogens have been analyzed in the bio-slurry and slurry compost. With regards to hook worm and pin /thread worm was not detected where *Giardia lambia* has been detected in bio-slurry and slurry compost.

### Bio-slurry extension

Bio-slurry extension program under BSP Nepal was continued with change its extension modality.

#### Activity 1. Development of Extension Materials

*Plan:* Printing bio-slurry extension and promotion leaflet and poster- 22500 number.

*Implementation:* with the coordination of Nepal Biogas Promotion Association (NBPA), the bio-slurry leaflet and poster were developed and print in different languages for the different kind of biogas users and others.

*Result:* 20000 numbers of extension and promotion leaflets and posters were printed and about 16000 distributed to the biogas users, potential farmers and NGOs, CBOs, GOs etc are involved in biogas program.

#### Activity 2. Training

The BSP-Nepal has been implementing the training program on proper utilization of bio-slurry for the staff of Biogas Companies, biogas users, agricultural technician's etc. Maximizing the benefit from the biogas plant through optimum use of bio-slurry is one of the main objectives.

Plan	Implementation	Result
1. Training for Agricultural technician on	A training course was conducted jointly by Soil Management Directorate (SMD) and BSP-Nepal in the premises of District Agricultural Development	1. 324 agricultural technicians have been trained from 11

proper management of bio-slurry.  Target: 20 districts	Office (DADO). The training was given to the agricultural technicians of DADO. Districts were selected on the basis of number of biogas plant installation. The training cover the importance of organic manure and bio-slurry, proper handling and use, bio-slurry composting technique, storage and application etc. The agricultural officers who had taken ToT on proper use of bio-slurry last year were involved as resource person during the training.	different District Agricultural Development Offices.  2. They have started bio-slurry extension through their network.
2. Biogas user training  Target: 13100	The main actors of utilizing the bio-slurry are biogas farmers. They should have knowledge about the management of slurry. Realizing this, biogas companies have conducted the training to the biogas users. BSP-Nepal has trained technical persons of the company on slurry management. Company organized the Female user group training at the end of the year. In this training bio-slurry training also carried out.	1. 1114 biogas users have been trained on the proper management and utilization of bio-slurry from 16 July 2007 to 15 July 2008  2. Biogas User Survey (2008) indicates that the bio-slurry composting practices done by the users increased from 52 % last year to 64 % this year.
3. Training to biogas company personnel on slurry promotion and extension  Target: 100	Biogas company is frontline for the extension of bio-slurry. Every year the number of company is increased and some company have deputed the new staff. To upgrade the skill and knowledge of the new and old technical personnel of the company the training was conducted by the coordination of Nepal Biogas Promotion Association (NBPA). The training is conduct at regional level. NBPA collect the demand from the company and develop the training schedule accordingly.	The training will be started from October 2008 and 23 company staffs will be trained.

### Activity 3. Demonstration

The cattle urine is a good source of nitrogen fertilizer but biogas users have neglected this as wastage. In Nepal, the most of the cattle shed are in traditional type that means earthen and undulating floor, unmanageable for urine and dung collection etc. Realizing to convincing the users for proper collection and use of urine & dung as well as improve the quality of bio-slurry, demonstration was planned in the biogas households in the year 2007/08.

*Plan:* Demonstration effect on the improvement of the cattle shed floor for proper collection of dung and urine to input the biogas plant.

*Implementation:* with the coordination of biogas Construction Company, the site and biogas households were selected. The farmers having the vegetable farming and willingness to carry out the demonstration were considering. Total of 50 biogas

households in two different locations were identified for the demonstration. The concrete floor having slightly sloped in one side was constructed. The urine pit has 15-20 liters capacity was constructed at the end of the slope of the floor. Before implementation, the selected biogas users were oriented on the proper bio-slurry management and utilization as well as method of urine feeding into the plants.

*Result:*

1. After the cattle shed improvement, feeding in to the plant is properly.
2. The users feed average 12 liters of urine into the plant daily.
3. The stove was burn about 10-12 minutes more after cattle shed improvement.
4. The frequency of bio-slurry discharged is increased.
5. The biogas farmers nearby the village were visited to the demo households and interaction with biogas owners on the benefit of cattle shed improvement. And some of visited farmers have constructed the shed and managed the bio-slurry accordingly. The demo farmers have prepared the bio-slurry compost and now it is ready for application. The nutrient content in bio-compost and farmyard manure will be analyzed. The effectiveness of bio-slurry compost is demonstrated in vegetable crops.

### **Bio-slurry management and Utilization at Farm Level**

The biogas users' survey, regularly being conducted last few years, has also shown that majority of the biogas users having compost pits. However the number of pits varies with households. The size of the biogas plant and the availability of the space generally determine the number and size of the pit.

The recently accomplished biogas users' survey (2008) confirmed the popularity of pit method of composting and found that among the biogas users more than 92% of the respondents follow pit method. Generally biogas users keep compost in the pit for 3-4 months. The composting period is perhaps more determined by the time of application rather than decomposition.

Besides the composting, some users have practice to use the bio-slurry in liquid form. Biogas User Survey 2008 shows that about 10 percent biogas users were use as liquid form. The liquid form of bio-slurry is use in the kitchen garden.

#### **Bio-slurry storage**

The crop cultivation is seasonal while the bio-slurry production is continuous. Before the application, the bio-slurry compost is store by the users' in different ways. Some users have storage the compost properly and some are incorrectly. However the biogas users' surveys (2008) have identified the following storage and application modes being practiced by Nepalese farmers.

12. Spread and dried on the ground
13. Keep in heap uncovered
14. Keep covered in heap
15. Piled under a shed
16. Piled temporarily in the field
17. Spread in the field into small heaps uncovered
18. Transported and spread in the field with cover until field application

19. Transported to the field, spread and incorporated immediately
20. Transported to the field and spread during slack season and incorporated into soil only at time of land preparation

The practices of slurry compost storage and application popularly being followed by Nepalese farmers can be termed quite unscientific as the quality of the compost is greatly affected due to direct exposure to the sun and also the valuable nutrients are washed away by rain. The scientific practice is to incorporate in the soil immediately after transporting to the field. As a part of the bio-slurry extension program, this message was diffused through various mass media like radio, TV, leaflet distribution, users' training etc which seemed to have brought positive result.

### **Utilization of bio-slurry in different forms at farm level**

The bio-slurry can be applied in the field in different forms as described below. Biogas Users' Survey 2008 has reported that around 64% of the sample households utilize it in compost form, 12% in dried form, only 10% in liquid form and the rest 14% do not use the slurry at all. One of the main reasons attributed for not using the slurry is - latrine connection to the plants, bad odor and refusal by labor to handle the bio-slurry produced from latrine attached plants.

In some area farmers are use the bio-slurry as insecticide. They mix bio-slurry and water at the ratio of 1:4 and stir thoroughly then spray in vegetable crop like bean to control the aphids. Some users have sprayed this slurry concentration in potato during the cloudy weather for preventing the leaf rot.

Bio-slurry has been successfully used as fish feed in some fishpond of biogas farmers. The farmers used bio-slurry in two ways, first as a fertilizer in the fishpond and second as a feed to fish. Bio-slurry was applied at a dose of 100-150 kg/*kattha*<sup>3</sup> initially before water irrigation in the pond. The fingerlings stocked in the pond need highly nutritious feed in first month. The first month feed was prepared with the wheat or maize flour, soybean, fish meal and mustard cake. The mixture of 20% of each of these ingredients was fed to the fish at the rate of 3 percent of the total body weight. From the second month 20 percent slurry was added to the total weight of the feed; and from the third and fourth month 30 percent slurry, 20 percent flour and 50 percent rice bran were mixed for preparing the fish feed. The fish were fed twice a day, once in the late morning and next in the afternoon. The feeding was done in the form of balls of the feed mixture, which were inserted into the pond by keeping in pans and suspending in the pond water at a depth of one foot from the surface. Water hyacinth was also grown in the pond to purify water.

### **Limitation**

In relation to organization and manpower

The bio-slurry program is implementing by the BSP-Nepal with the coordination of different partner organization. One Slurry Coordinator is deputed by the BSP-Nepal to

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<sup>3</sup> 1 *kattha*=333 m<sup>2</sup> or 0.0333 ha.

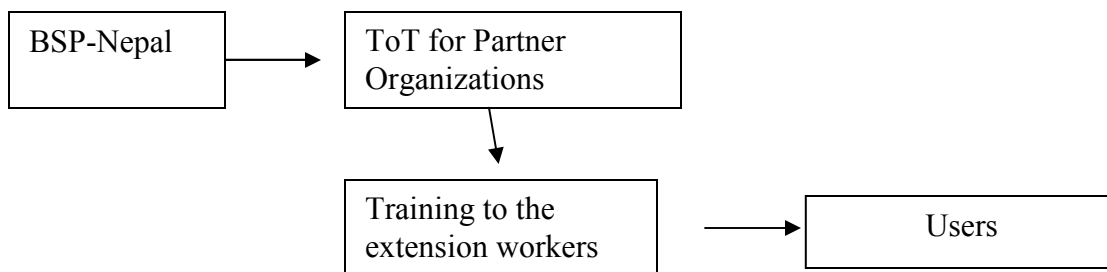
conduct and coordinate bio-slurry program. The biogas construction companies are the front line of bio-slurry extension. **Most of the construction companies and biogas users do not pay adequate attention to bio-slurry.** Sometimes trained manpower's are dropout and it hampers the promotion of bio-slurry. The Department of Agriculture (DoA) and Department of Livestock (DoLS) are the more related organizations for the sustainable bio-slurry extension in the country. The involvement of Department of agriculture is just begun but still to takes time for the extension through their network because of the lack of policy on bio-slurry and technical manpower. The linkage between Department of Livestock and biogas program is not made properly but in the coming days it could be possible.

In relation to technology – storage, drying, transportation, use etc.

Available improved technologies are not practiced by the majority of the farmers because of lacking knowledge.

Uses: The biogas users have used the bio-slurry in different form. They do not have much conscious about the right way of handling during the application. Improper and mishandling affect the quality of bio-slurry by declining the nutritive value. The limitation is that farmer could not manage the nutrient loss properly during the use. Generally farmers spread the bio-slurry or compost in field and left for some days which causes the nutrient loss due to the exposure in sunlight. Besides the use as manure, other option for utilizing the slurry is not properly identified. Some users were applying the bio-slurry on their own experiences. In depth research findings were not documented regarding the bio-slurry use as pesticide/insecticide, vermi-composting, pig feed etc.

In relation to approach, method(s) and technique(s) used for training and demonstrations



BSP-Nepal provides bio-slurry management and utilization training to the biogas construction companies who further provide the skills to the biogas users. Most of the biogas construction companies are not fully aware on importance of slurry. They do not give priority on it. The involvement of Agricultural Institutions such as Department of Agriculture (DOA) and Nepal Agricultural Research Council (NARC) is lacking.



## **Lesson learned and opportunity**

### Lesson learned

The Biogas Company is the main actor for dissemination of the technology in grass root level. The dependent on company for transferring the techniques of bio-slurry management and utilization to the biogas users needs company staffs should have sufficient knowledge in bio-slurry extension and promotion. The successful users on bio-slurry management are the key persons for extension therefore involving those users are helpful to motivation of others. The recording of the successful stories in order to disseminate appropriately through the different media make a mass coverage of the biogas users. The importance of bio-slurry at user level should be demand based rather than technology driven. The department of agriculture is the apex organization in the country for the development of agriculture sector. They have good networking in grass root level so that strong coordination with them for extension of bio-slurry is realized.

### Opportunity

- Growing realisation of the importance of organic manure
- Use of bio-slurry in high value and export oriented crops
- Saving of money in the purchase of chemical fertiliser
- Extension of its use as supplement feed for fish, pigs, etc.
- Extension of slurry use as pesticide/insecticide.
- Income generation by selling bio-compost (e.g. through vermi-composting)
- The department of agriculture has good networking system at grass root level

### **Future plan**

To maximize the bio-slurry utilization in the country the following activity will be carryout in future.

1. Updating the existing bio-slurry extension materials.
2. Continue the applied research at farm level.
3. Demonstration activity in some potential district with the coordination of District Agricultural Development Office.
4. Training to Biogas Company personnel and biogas users on bio-slurry management.
5. Continue to bonus scheme to Biogas Company on the proper management of bio-slurry.

### **Conclusion and Recommendation**

#### Conclusions

Different activities and studies conducted till date in Nepal on bio-slurry management and utilization shows that its potential is being realized by the farmers, the target beneficiaries, along with the increasing awareness created due to various extension programs and its utilization is getting popular day by day. However, there is still to overcome the constraints in bio-slurry use and improve its utilization. Conducting more extensive training programs at users' level for transfer the knowledge on bio-slurry use to farmers in every corner of the country is a primary task. In rural context, convincing the

biogas farmers that slurry from latrine attached plants is also good for crops, and that it can be used safely with proper handling methods is a major challenge. The awareness creation activities among the rural people about multi-advantages of bio-slurry are needed. Similarly, storage and application of slurry to the field has been another constraint for effective use of bio-slurry. Improper method of storage, composting and application may cause reduction in nutrient value that will affect farmers' perception on bio-slurry adversely. Slurry extension programs, demonstrations and training have been highly functional in knowledge propagation.

Involving the Department of Agriculture for extension of bio-slurry through their network should get top priority. Bio-slurry program should be tie up with organic farming. The organic farming in different crop becomes more popular and profitable to the farmer.

### Recommendations

The following recommendations have been made for sustainable bio-slurry extension in future, are:

- 1) The Department of Agriculture should be involved for the sustainable bio-slurry extension and agricultural production. For that linkage between the concern institutions should be strengthen.
- 2) The linkages between BSP Nepal and the organic farming organizations should be strengthened.
- 3) For mass dissemination of bio-slurry use, national and local radio, FM, TV channel, street program etc should be used properly.
- 4) Massive training materials like audio-visual elements, pictorial pamphlet's, etc demonstrating multiple utilities of bio-slurry should be used extensive knowledge dissemination to the targeted group.
- 5) Research should be done time to time for up-dating the old data in the present situation.
- 6) Develop the simple leaflets in local languages.
- 7) Orientation on bio-slurry extension and promotion to the partner's organization, school teachers should be carried out.
- 8) The sound techniques of storage, processing, transportation and application should be adopted so that handling of bio-slurry is done in healthy manner.
- 9) Awareness raising and training should be carried out to overcome the reluctance's of farmers to use bio-slurry from latrine attached bio-digesters.
- 10) Biogas Company should have package program to their users on bio-slurry.
- 11) Make sustainable linkages among the biogas adopted countries to share the new innovation on bio-slurry.
- 12) Research could be extended to use slurry as fish feed, pig feed and composting

## **Country Report of Ethiopia**

### **Introduction and Background**

Ethiopia with a total land area of 1.1 million km<sup>2</sup> is the tenth largest country in Africa. It accommodates Africa's third biggest population, currently about 75 million people.

Ethiopia's physical landscape is characterized by great topographic variations; arid and semi arid low lands, dissected plateaus and massive mountains often traversed by deep river gorges and valleys.

The structure of the economy is dominated by agriculture, which contributes 40.1% of the country's gross domestic product (GDP), 90% of the export earnings and 80% of the employment.

Traditionally, Ethiopia's most important agricultural export commodity is coffee, followed by pulses, oil seeds and chat. Crops contributing to household food security vary over the different areas, but include teff, wheat, barley, maize, sorghum, finger millet and pulses.

Despite its immense contribution to the national economy, the agricultural sector is largely characterized by subsistence farming. Frequent droughts and poor cultivation practices negatively impact production.

The average landholding is small; current estimates mention about 1 ha per holding, and under Ethiopian farming conditions often insufficient to sustain the household. The sector is nearly totally dependent on rainfall, with less than 2% of the total arable land being irrigated. Ethiopia is the water tower of the region with 110 billion m<sup>3</sup> of surface water with an irrigation potential of 3-5 million ha excluding rainwater harvesting and underground water.

Chemical fertilizer is recognized as one of the key means to increase agricultural yields. Fertilizer use has been promoted under the previous as well as the current governments with distribution systems, extension and credit. But the price of chemical fertilizers had gone beyond the purchasing power of most farmers in the region. Traditionally, many of the rural households in the highland parts of Ethiopia use dung as fertilizer. Unfortunately, shortage of energy for cooking increasingly forced many of the households to use dung as energy source.

The livestock population in Ethiopia is the second largest in Africa, and livestock is an integral part of the farming system and is highly linked to land/soil and water resource management. There is serious degradation related to intensive cultivation, overgrazing, deforestation, soil erosion, poor water control, shortage of livestock feed and fuel wood crisis.

## **Biogas Technology in Ethiopia**

Biogas technology was introduced in Ethiopia as early as 1970's, when the first batch type digester was constructed at the Ambo Agricultural College. This was complimented by NGOs constructing toilet-linked biogas digesters in households, schools, monasteries, prisons etc. In the last two and half decades around 1000 biogas plants, ranging in size from 2.5 m<sup>3</sup> to 200 m<sup>3</sup>, were constructed in households, community and governmental institutions in various parts of the country. Presently, approximately 40% of the biogas plants that were constructed are not operational due to a lack of effective management and follow-up, technical problems, loss of interest, reduced animal holdings, evacuation of ownership, water problems, etc.

Due to the renewed interest in biogas, a National Biogas Program (NBP) for Ethiopia has been initiated and in the first phase of the program it is planned to construct 14,000 biogas plants, with a potential to upscale construction to 100,000 biogas plants in the next phase. Bio-slurry has been included as one of the main components of NBP.

## **Status of Bio-slurry Activities**

### **Research**

NBP has identified research activities to assess the impact of bio-slurry on crop production and the reduction of CO<sub>2</sub> emission. These research activities will be implemented by capable research institutes on the basis of project proposal and ToR to be developed by the NBP Coordination Office.

### **Bio-slurry Extension**

#### **Activity 1. Development of Extension Materials**

A hand book on compost preparation and utilization was developed by the Institute for Sustainable Development and Environmental Protection Authority of Ethiopia. The book was presented to the Minister for Agriculture and Rural Development who appreciated and ordered the distribution to all regions of Ethiopia.

#### **Activity 2. Training**

In 2007, Institute for Sustainable Development trained 415 farmers and development agents from 15 districts of the three regions (Tigray, Amhara and Oromiya regional states) regarding compost preparation and application. This training is also continued in 2008 and will expand after a stakeholder meeting which will take place in the coming few months with the participation of the Ministry of Agriculture and Rural Development, Regional Bureaus of Agriculture and Rural development and Concerned NGOs. Intensive training on how to make and apply compost is expected from ISD.

NBP also has a plan to train extension agents on how to effectively use bio-slurry. But it has to give the training equal consideration with the designing and construction of the biogas plants.

### **Bio-slurry Management and Utilization at Farm level**

Farmers have been manuring their crops since time immemorial. Proper application of slurry (direct or diluted, dried and composted) on the vegetable garden was not an exception, and farmers reported increased yields and reduced weeding. Institutes such as Bio-farm, Genesis farm, and schools such as Kokebe tsebah Senior Secondary school and higher 12 medium technical and Vocational Institute are applying the bio-slurry on their farms.

#### **Limitation**

- Ethiopian Rural Energy Development & Promotion Center has limited capacity for promoting the construction of biogas digesters and follow-up.
- Masons are limited in number and capacity to construct effective bio-digesters.
- Limited number and capacity of organizations for making better appliances.
- Present storage system of dung and bio-slurry resulted poor manure quality i.e. loss of the nutrients (especially nitrogen) by volatilization due to exposure to sun (heat) as well as by leaching.
- With the diminishing area of landholding the number of cattle-holding/ha has also been reduced significantly

#### **Opportunities**

- The increasing price of inorganic fertilizer has heightened interest in the use of livestock manure for supplying crop nutrients.
- The increasing price of organic products stimulates the increased utilization of organic fertilizer
- The extension system of the Bureau of Agriculture would be an asset for a large scale dissemination of biogas and bio-slurry program.
- The existence of institutions (such as ISD, Lem Ethiopia, World Vision, Prison fellowship of Ethiopia, ENDA Ethiopia, etc) who are interested to promote biogas digesters as well as working with farmers on organic farming.
- Presence of funding agencies like UNDP-GEF, Financial support of the Netherlands government etc.
- The present environment policy supports organic agriculture.

#### **Future plan**

The National Biogas Program aims to build 14,000 biogas digesters in the first phase of the coming five years and thereby develop a biogas sector incorporating sustainable and environment friendly bio-slurry management system in Ethiopia.

## **Conclusion**

Bio-slurry is an excellent organic fertilizer which can make an important contribution to improve soil fertility, crop yield and protection of environment. The use of bio-slurry for various purposes in agriculture system can save expenditure for imported agro-chemicals to significant amount both at farmers' level and national level. However, there is a need of exploring its potential to maximum extent thorough researches and incorporation in extension systems so that farmers can be convinced for its proper utilization.

## **Recommendation**

- Awareness of biodigester users should be created on the proper management and utilization of bio-slurry.
- The capacity of the Ethiopian Rural Energy Development & Promotion Center should be buildup for promoting the construction and maintenance of biogas digesters.
- Farmers must shift from dung for fuel to dung for biogas production and use of effluent for increasing crop production.
- Farmers must start storing farm yard manure under shade as well as use bio-slurry as fertilizer directly in the field as it comes out of the plant to avoid loss of nutrients when stored and dried.

## **Country Report of Cambodia**

### **Introduction**

Cambodia covers a total land area of 181,035 square kilometres. It is home to about 14 million people (2008). Farming is mostly based in an integrated system combining crop production and animal husbandry. Crop production main constrictions are inefficient irrigation management, lack of agriculture inputs (good quality seeds and fertilisers), and imbalanced use of fertilisers, insufficient institutional support and instable price of agricultural production. In some areas near the border with Vietnam, pest control (grey leaf hopper) is an annually returning problem.

There are two rice cultivation seasons, dry (irrigated) and wet rainfed season. The average rice crop yield in wet season is 2.4 tons/ha and dry season 3-4 tons/ha. It is still low as compared to the neighbouring countries. For the most part, the area under rice cultivation during the wet season is kept fallow during the dry season because of water deficiency. The most dominant cropping patterns are Rice-Rice and Rice-fallow. Mostly traditional varieties are used but in some irrigated areas modern varieties are grown in dry season. Farmers use both organic and inorganic fertilisers.

## **Bio-digester program in Cambodia**

National Bio-digester Program (NBP) under the Ministry of Agriculture, Forestry and Fisheries (MAFF) started in May 2005 with technical support from the Netherlands Development Organisation (SNV). But the program actually started its implementation from March 2006.

From 2006 up to the present (Sep. 2008), 3224 digesters are built; 294 plants in 2006, 1150 in 2007 and 1780 plant in 2008. Bio-slurry extension is an integral component of NBP.

### **Status of Bio-slurry Activities**

#### ***Bio-slurry component***

The bio-slurry extension component of NBP took shape by mid 2006, about 3 months after the program launched. Within the NBP, the component activities are planned, monitored and reported by a Bio-slurry Extension Officer who is supervised by the Program Office Coordinator. Under the partnership with the Provincial Departments of Agriculture (DoA), 2-4 staffs of the DoA (Agronomy and Agricultural Extension office) are assigned as Bio-slurry Extension Workers. These Extension workers are working under coordination of the Provincial Bio-digester Program Office (PBPO) with technical support from the National Bio-slurry Extension officer. CEDAC- an agricultural NGO selected as partner organization of NBP. CEDAC has assigned one Project Coordinator at national level and one Community Facilitator Assistants (CFA) in each province, for slurry extension work.

#### ***Participatory Action Research***

In Participatory Action Research approach, model farmers play role in implementing, managing and observing field experiment conducted in their field with technical assistance by the extension workers or CFA. The experiment is mainly focus on the comparison of three treatments of fertilizer application. The extension workers or CFA are involved in designing, collecting data and evaluating results with the model farmers. At the model farmer's house a set of slurry management tools (slurry pit and composting hut with shade and boundary) has to be present. Up to October 2008, trials with 204 model farmers have been conducted.

Based on the results from field experiment, some brief conclusion would be drawn as follow:

- Bio-slurry application in crops is more effective than FYM.
- Applying only bio-slurry is not sufficient for crop production.
- Integrated use of bio-slurry and chemical fertilizer in rice and vegetables gave satisfactory increase of crop yield.

**Note: Quantitative data need to be presented.**

### ***Bio-slurry Extension Activities***

Training and promotion material

A leaflet on general information about NBP covering bio-slurry component activities has been developed-2000 copies.

A poster on bio-slurry management has been developed - 2000 copies.

An instruction booklet for bio-digester users has been developed - 2500 copies.

Training

Pre-construction training

Preconstruction training or village workshop is usually conducted at village or commune level. Potential and interested farmers are invited to attend this training. The objective of this training is to introduce farmers to the bio-digester technology and its advantages. The value of bio-slurry is also introduced to the participants. **(How many conducted in 2008?)**

Training for extension workers

The extension workers are selected from the provincial departments of agriculture, especially from the agronomy or agricultural extension office. Commune Facilitator Assistants (CFA) of CEDAC was also selected for the training. The training was conducted on provincial level by the NBP extension officer and contains the following topics:

- value of bio-slurry;
- how to manage and use bio-slurry;
- how to select model farmers;
- how to manage field experiments;
- how to record and compile the recorded data, and
- how to work with farmers.

Totally, 28 extension workers and 9 CFA were trained. However, only 18 extension workers and 7 CFA are still active.

The table below shows the distribution of bio-slurry extension workers over the NBP provinces.

Training for masons and supervisors

Masons and the provincial supervisors were trained on slurry management and application. The objective of this training is to improve knowledge and practices of masons and provincial supervisors on the value of bio-slurry, slurry management, utilisation, and how to encourage farmers to manage bio-slurry properly. The masons and supervisors are expected to train users at the different stages of plant construction and operation, from the initial feasibility visit to the actual construction and after-sales visits. Bio-slurry management and application is integrated in the national mason and supervisor training at Praeh Kosamak Polytechnic School.



**Note: How many masons & supervisors were trained in how many batches in 2007 and 2008?**

User training

After plant construction all bio-digester owners have the right to get training on how to use and maintain digester. These trainings are organised by the respective PBPOs, 20-30 participants are invited per training. In these trainings, the Extension Worker is always invited to deliver a lecture on slurry management and its application.

Up to now 848 digester owners were trained (26.3% of total owners).

Farmer exchange visit

In farmers exchange visits or study tours bio-digester owners are bring to visit a model farmer's bio-digester and bio-slurry activities and share experiences with other farmers. The extension worker explained how to improve slurry management and utilization. Based on this experience, most of the participants plan to improve their slurry management after the visit. Up to now 650 were invited to attend exchange visit but there are no hard figures on how many have adopted the new slurry management methods. The impact of this important activity is being studied and the result will be up dated in future.

Provincial workshop

Provincial workshops on management and utilization of bio-slurry were planned to be conducted in 6 provinces. These workshops aim to disseminate information (awareness rising) on the use of bio-slurry in agriculture and looking the possibility of getting support form different stakeholders in promotion of bio-slurry activities.

Participants from Provincial Department of Agriculture (Agronomy and Agricultural Extension), officials from district agricultural office, commune council, and relevant provincial department such as Provincial Department of Environment, Health, Women Affaire, Education and staffs from relevant NGOs will be invited. About 70 participants will attend in this workshop at each province.

This provincial workshop will be conducted for one day and consist of presentations, group discussion and open discussion. Some model farmers and CEDAC representative will be invited to do presentations on their findings related to bio-slurry management and application at the fields.

**Note: How many workshops were planed and conducted in 2007 and 2008?**

## **Bio-slurry Management and Utilization at Farm level**

Some farmers manage their bio-slurry as they managed their FYM before construction of bio-digester (only making a pile of FYM without boundary and shade). Fifty four digester owners had been interviewed as a part of study conducted by a student from the Royal University of Agriculture in Kompong Cham province. The result showed that 43 digester owners of 54 have one big slurry pit near by the outlet. 35 owners of 54 built boundary surrounding slurry pit. Only 13 owners of 54 have built composting hut with proper shade. However, the other farmers have planned to build good composting hut but now they do not have enough money.

After digester construction, the average volume of organic fertilizer has been increased from 4.46 ton to 6.68 ton/ year. About 50% of digester owners used bio-slurry crop fields and fish pond (5 owners used in rice, 9 in vegetables, 7 in fruit trees, and 5 in fish pond. The digester farmers have reduced chemical fertilizer 39 kg per hectare in rice. Moreover, the rice yield had been increased from 1992 kg to 2046 kg/ha.

Most of digester owners are aware of the advantage of bio-slurry and use it in both rice field and vegetable garden. Normally, farmers prefer to use bio-slurry as basal in rice fields and, basal and top dressing for vegetable cultivation.

Bio-slurry is used as fish feed mixing with other materials like bran, broken rice, and vegetable.

## **Monitoring and evaluation**

Bio-slurry extension activities at the field level are directly supervised by the PBPO Coordinator or Director. The Bio-slurry extension officer from NBP frequently visits the provinces and monitors the progress of planned activities. After the field visits, reflection and feedback is provided to the concerned PBPO and extension workers. A back to office report is also submitted to the NBP programme coordinator.

## **Limitations**

In relation to the organisation structure and manpower, the following limitations are observed:

- At the provincial level, the PBPO Coordinator and the Directors are very busy and have no time to follow up field activities and work plan. They focus on promotion and plant construction activities; slurry extension does not have a high priority at their level. It has to be noted that PBPO Coordinator and Director get incentive from plant construction and they get nothing from bio-slurry promotion activities. However, the bio-slurry extension activities are part of their tasks.
- The PBPO supervisors have less attention for bio-slurry promotion; they mostly engaged themselves in plant promotion and quality control. The reason might be no additional incentive for slurry extension activities.

- Due to low incentives, some trained extension workers dropped out after joining the program.
- There are not enough bio-slurry extension staffs at district level. The extension workers are mostly selected from the provincial capital, so, they need to travel long distances if they want to follow-up activities at district and commune level.
- The technical capability of extension workers and CFAs still is limited. Some extension workers have no agricultural background and they just received training on general agricultural and extension.
- The cooperation between PBPO extension workers and CFA is not very good, especially on planning. Both PBPO and CEDAC plan their activities independently so they can overlap activities in some district while other districts are not covered at all.

In relation to technology (storage, drying, transportation and use) the following limitations are at time observed:

- Information materials like manuals are distributed to the users but most people do not read them.
- Some farmers were inactive in collecting and putting other materials in composting hut, so the slurry is never solidify and is difficult to apply in the field.
- Some farmers built composting huts that are too small; they do not have enough volume to store slurry for a whole year.
- Some farmers do not carry bio-slurry from the slurry pit to the composting hut.
- Some farmers built their digesters without slurry pit and composting hut and are difficult to convince them to do this at a later stage.

### **Lesson learned**

- When user training or farmers exchange visit is organized one of the family member is invited, usually the man (family head) is attended. However, the woman of the house is also very much involved in digester operation and crop production so both of them should be invited.
- Farmers are very happy with applying slurry for fish and earth worm culture.
- Applying bio-slurry in combination with chemical fertilizer is very effective for yield improvement.
- The extension workers have not enough time to do follow up field experiments. Sometime data collection is relying on farmers; consequently data collected is not always reliable.
- Most of farmers do not like to participate in experiments because they are required to do monitor and collect data regularly.

### **Future plan**

- The present organisational structure of the bio-slurry component of NBP will be changed following the recommendations of the Bio-Manure Management Advisor, SNV Bangladesh and Mid-term review team.
- At PBPO level a separate bio-slurry extension coordinator having agronomic background will be selected to coordinate bio-slurry activities in each province.

All bio-slurry extension workers should have adequate background in agriculture and work in their own district.

- CEDAC will be assigned to work in their targeted provinces separate from PBPO.
- Bio-slurry extension activities can be placed and coordinated at district level by assigning a staff who has background in agronomy. All bio-slurry extension workers will work under the coordinator and they should reside at their respective working places at district level.
- NBP can make an arrangement with the DoAs and CEDAC to increase the number of extension workers and CFAs depending on the area coverage and volume of activities.
- The bio-slurry coordinator in each province will be involved in developing program planning and the proposals will be submitted to NBP for approval.
- The participatory action research will be changed to field demonstration approach.
- Gender sensitive promotion is very important. Women are very much involved in biogas operation, slurry management and its application. To enforce proper slurry management and application, women must be involved in all trainings, both plant operation and slurry use.
- The mason and PBPO supervisor will be more involved in slurry management, especially at the beginning of plant construction.

### **Conclusion and Recommendation**

About 54% of digester owners have been trained, this is still lower than target (70%). The reason is that the digester farmers are very much spread over the provinces (low density). This makes it difficult to organise trainings (few people in one place). On the other hand, the number of extension workers in each province still is very low.

A training manual on bio-slurry management and utilization should be developed for extension officers and workers. User training program should be further strengthened.

## **Country Report of Bangladesh**

### **Introduction**

Bangladesh occupying a total area of 147 thousand square kilometer having a population of 147 million, one of the most densely populated country of the world. As biggest delta its 80% area is floodplain and 12% hills & 8% terraces. Cultivable and forest land is estimated at 8.3 and 2.6 million hectares, respectively.

Bangladesh has a wide range of environmental conditions having 30 agro-ecological regions and 88 sub-regions. These regions have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. Land is intensively used having a cropping intensity of 180%. Intensive use of high yielding varieties of crops has lead to a sharp increase in

removal of plant nutrients. Most soils of Bangladesh have organic matter content below critical level (< 2.0%) and which is depleted 5 to 36 per cent (average 11%) over last three decades. Combined use of organic and mineral fertilizers is the crucial factors to the overall maintenance of soil health and sustaining crop productivity in intensive cropping systems.

There are three major crop seasons in Bangladesh as follows:

Rabi Season: 16 October-15 March

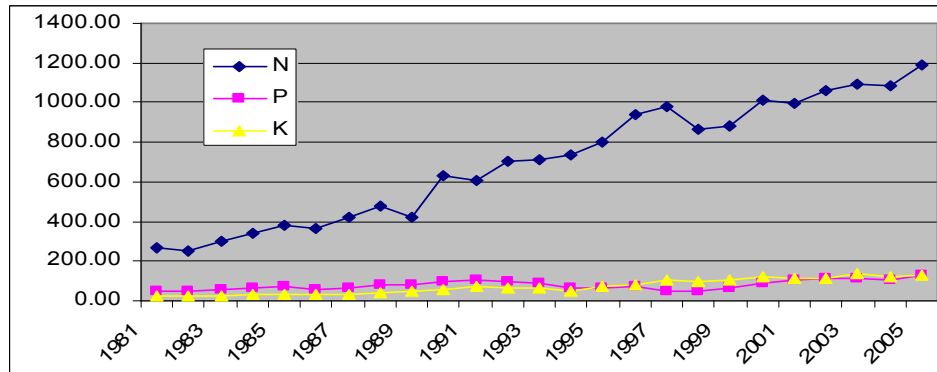
Kharif I: 16 March-15 July

Kharif II: 16 July-15 October

The major predominant cropping pattern under irrigated condition is Boro -T.aman rice and the second important one is Wheat-T.aman rice. Few farmers take three crops also.

Farmers depend mainly on inorganic fertilizers, organic manure, green manure and crop residues for soil fertility management

The current fertilizer use in Bangladesh is imbalanced.

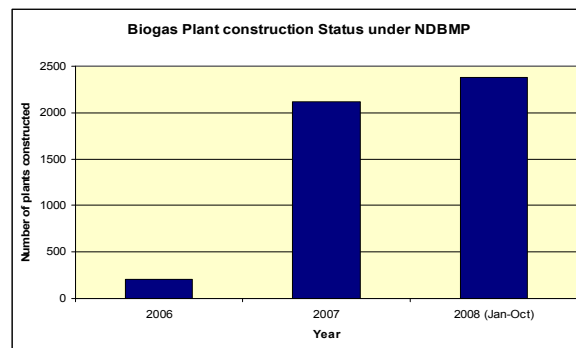


**Fig. 1: Fertilizer sales by nutrients by year**

### Biogas Program

First biogas plant was constructed in 1972 at the premises of Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. Thereafter through several projects under different organizations constructed about 24 thousands of biogas plants in different parts of the country. Infrastructure Development Company Limited (IDCOL) is implementing National Domestic Biogas and Manure Program (NDBMP) with support from the Netherlands Development Organization (SNV) since July 2006.

NDBMP initiated installation of biogas plants in mid 2006 and plant construction increases yearly. As of October 2008 4696 plants are installed.



## Status of Bio-slurry Activities

### Research

Maintenance of soil fertility is a prerequisite for long term sustainable crop production and it is certain that organic manure (cowdung, poultry manure and their slurry) can play a vital role in the sustainability of soil fertility and crop production. Bio-slurry can improve the physical and biological quality of soil by adding organic matter to the soil. It also provides both macro and micro-nutrients to crops.

It is important to evaluate the quality of bio-slurry and its effect on performance of different crops and soil fertility.

The following activities were planned:

- Collection of literature on bio-slurry and its management and utilization
- Conduction of research
  - Laboratory analysis
  - On-station trials
  - On-farm trials

### Evaluation of bio-slurry and slurry compost as a source of organic manure

Laboratory analysis of soil, plant and bio-manure samples were done at central laboratory of Soil Science Division of BARI following standard procedures.

The status of laboratory analysis of soil, plant and bio-manure samples is given in Table 1.

**Table 1. Status of laboratory analysis of soil, plant and bio-manure samples**

Item	Planned number of samples			Number of samples analyzed		
	Biomanure	Soil	Plant	Biomanure	Soil	Plant
Soil Samples-Initial	-	77	-	-	52	-
- Post harvest	-	48	-	-	48	-
Plant Samples	-	-	194	-	-	194
Manure Samples	231	-	-	45	-	-

Bio-slurry project was started in delay and again Tornado ‘SIDR’ attacked most of the area of Bangladesh in November 15, 2007 causing serious damage of crop, infrastructure and other wealth. As a result, some of the on farm trials were not conducted. So, the analysis of initial soil and manure samples were less than the planned number of samples.

An investigation was conducted to determine manural quality for Bio-slurry and slurry compost during January to April, 2008. A total of 28 Bio-slurry samples were collected of which 16 were cowdung based and 12 were poultry based. Six bio-slurry compost samples were collected of which 3 were CD based and 3 were PM based. Five cowdung samples and 6 poultry manure samples were also analysed to compare with Bio-slurry and bio-slurry compost. These samples

were analysed for pH, organic matter, essential plant nutrients (N, P, K, S, Ca, Mg, B, Cu, Fe, Mn and heavy metals (Co, Ni, Cd, Pb & As).

pH, organic matter and nutrient status of organic manure, bio slurry and slurry compost is presented in Table 2.

## pH

pH value of poultry litter based manure, bio-slurry and bio-slurry compost were higher than that of cowdung based manure, bio-slurry and bio-slurry compost.

## Organic matter content

Average organic matter content was higher in cowdung based manures than that of poultry litter based manures.

**Table 2. pH and nutrient status of different organic manure sources**

Source of Org. Man.	pH	OM %	Ca	Mg	K	N	P	S	B	Cu	Fe	Mn	Zn
			meq/100 ml			%							
Cowdung (Sample-5)	6.4	20	2.0	0.52	0.23	1.02	0.7	0.3	0.05	0.003	0.23	0.07	0.018
CD Slurry (Sample-16)	6.3	25	2.2	0.89	0.33	1.37	0.8	0.3	0.06	0.003	0.34	0.09	0.021
CD compost (Sample-3)	6.6	22	2.9	1.54	0.39	1.69	0.8	0.5	0.02	0.003	0.38	0.13	0.032
Poultry man (Sample-6)	6.9	19	4.9	1.68	0.40	1.71	0.7	0.4	0.06	0.004	0.23	0.07	0.021
PM Slurry (Sample-12)	6.7	19	6.2	2.08	0.48	1.84	0.8	0.3	0.03	0.006	0.29	0.09	0.025
PL Compost (Sample-3)	7.8	22	7.0	1.72	0.80	2.60	0.9	0.4	0.02	0.005	0.33	0.08	0.031
Accepted value (Min.)	6.0	17	-	-	-	0.50	0.5	0.1	-	0	-	-	0
Accepted value (Max.)	8.5	43	-	-	-	4.00	1.5	0.5	-	0.050	-	-	0.100

Nutrient content of both CD bio-slurry and PM bio-slurry were higher than aerobically decomposed cowdung and poultry manure.

## Primary nutrient

Average nitrogen content is higher in PM (1.71%) & PM slurry (1.84%) than that of CD (1.02%) & CD slurry (1.37%). In spite of higher OM percentage in Cowdung, % N was higher in poultry manure as because C: N ratio is higher in Cowdung and lower in Poultry manure.

Higher amount of P was present in PM slurry (0.5-1.4%) and CD slurry (0.5-1.4%) compared to PM (0.4-1.2%) and CD (0.4-1.1%). These results confirmed the findings of Joshi *et. al.*, 1994.

Mean K content was higher in poultry manure (0.40), poultry slurry (0.48) & PM slurry compost (0.80) than that of cowdung (0.23), cowdung slurry (0.33) & CD slurry compost (0.39).

### Secondary nutrient

The concentration of Ca in poultry manure (3.1-7.5), poultry slurry (2.9-8.6) & PM slurry compost (5.0-8.6) were higher than that of cowdung (0.5-3.7), cowdung slurry (7.0-8.2) & CD slurry compost (2.6-3.2).

Similarly, Mg content of poultry manure (1.09-2.11), poultry slurry (1.46-2.74) & PM slurry compost (1.34-2.16) are higher than that of cowdung (0.16-0.69), cowdung slurry (0.25-1.74) & CD slurry compost (1.06-2.10). Because bone meal, fish meal and shell dust used as poultry feed containing appreciable amount of Ca and Mg.

Higher amount of S are present in PM slurry (0.2-0.6%) and CD slurry (0.2-0.6%) compared to PM (0.2-0.5%) and CD (0.2-0.4%). These results confirmed the findings of Joshi *et. al.*, 1994.

### Micro nutrients

Micronutrient concentration in bio-slurry was higher than aerobic decomposed manure of cowdung and poultry manure.

### Heavy metal

Cobalt, nickel, cadmium and arsenic content of cowdung & poultry manure and their bio-slurry were within the safe limit. Lead concentration of poultry manure, poultry bio-slurry and poultry bio-slurry compost were higher than that of cowdung, cowdung bio-slurry and CD bio-slurry compost. Lead content of poultry liter based manure and bio-slurry were more than 30  $\mu\text{g g}^{-1}$ . Heavy metal concentration follows the order of: Poultry manure > PM Slurry > PM compost. It needs to analyse more number of samples preserved under different conditions and periods for further confirmation..

**Table 3. Heavy metal status of different organic manure**

Sources	$\mu\text{g/g}$				
	Co	Ni	Cd	Pb	As
Cowdung (Sample-5)	9.4	11.6	1.46	26.5	4.72
CD Slurry (Sample-16)	7.3	10.2	0.98	13.2	2.38
CD compost (Sample-3)	9.6	10.7	0.7	15.3	1.7
Poultry manure (Sample-6)	12.0	16.2	1.4	38.4	9.20
PM Slurry (Sample-12)	8.4	11.4	1.1	46.4	7.85
PL Compost (Sample-3)	9.8	12.8	0.6	22.7	4.9
Accepted value (Min.)	-	0	0	0	0
Accepted value (Max.)	-	30	5	30	20



## On-station trials

The status of on-station experiment is given in Table 4.

**Table 4. Status of on-station experiment**

Planned			Executed		
No. of experiment.	No. of crops	No. of sites	No. of experiment.	No. of crops	No. of sites
01	02	02	01	02	02

### **Experiment:** Effect of Bio-slurry on the Yield and Nutrient Uptake of Cabbage and Cauliflower

Two separate experiments were conducted under irrigation condition during the rabi (October-March) season of 2007-08 at BARI central farm under AEZ 28 (Madhupur Tract).

Six treatments each was replicated three times in a randomized complete block design. Treatments used were as follows:

T<sub>1</sub>: Soil test based (STB) inorganic fertilizer for high yield goal

T<sub>2</sub>: Integrated Plant Nutrient System (IPNS) with 5 t ha<sup>-1</sup> cowdung plus inorganic fertilizer for high yield goal

T<sub>3</sub>: IPNS with 5 t ha<sup>-1</sup> cowdung bio-slurry plus inorganic fertilizer for high yield goal

T<sub>4</sub>: IPNS with 3 t ha<sup>-1</sup> poultry manure plus inorganic fertilizer for high yield goal

T<sub>5</sub>: IPNS with 3 t ha<sup>-1</sup> poultry bio-slurry plus inorganic fertilizer for high yield goal

T<sub>6</sub>: Native fertility (no fertilizer used)

### **The rate of manure and nutrients used in different treatments are given below:**

Crops	Treatment	Nutrient (kg/ha)								
		N	P	K	S	B	CD	CD slurry	PM	PM slurry
Cabbage	T <sub>1</sub>	<b>200</b>	<b>79</b>	<b>88</b>	<b>23</b>	<b>1</b>	0	0	0	0
	T <sub>2</sub>	180	69	73	20	1	5000	0	0	0
	T <sub>3</sub>	176	66	71	19	1	0	5000	0	0
	T <sub>4</sub>	178	68	72	19	1	0	0	3000	0
	T <sub>5</sub>	174	65	69	18	1	0	0	0	3000
	T <sub>6</sub>	0	0	0	0	0	0	0	0	0
Cauliflower	T <sub>1</sub>	<b>136</b>	<b>73</b>	<b>80</b>	<b>19</b>	<b>1</b>	0	0	0	0
	T <sub>2</sub>	116	63	65	16	1	5000	0	0	0
	T <sub>3</sub>	112	60	63	15	1	0	5000	0	0
	T <sub>4</sub>	114	62	64	15	1	0	0	3000	0
	T <sub>5</sub>	110	59	61	14	1	0	0	0	3000
	T <sub>6</sub>	0	0	0	0	0	0	0	0	0

Different nutrient package significantly influence the yield and yield components of cabbage and cauliflower. Highest head yield of cabbage (93.65 t/ha) & curd yield of cauliflower (53.77 t/ha) were obtained from T<sub>5</sub> treatment (3 t ha<sup>-1</sup> PM bio-slurry plus IPNS base inorganic fertilizer) which was close to T<sub>3</sub> treatment (5 t ha<sup>-1</sup> CD bio-slurry plus IPNS base inorganic fertilizer).

However, the treatment where poultry slurry was used showed higher yield and higher economic performance. Both gross margin and MBCR were higher where both organic & inorganic fertilizers were incorporated to soil compared to only inorganic fertilizer (T<sub>1</sub> treatment).

Table 5. Effect of different nutrient package on the yield and return of Cabbage

Treatment	Whole plant weight (kg)	Marketable weight (kg)	Head yield (t/ha)	% increase of head yield over		Gross return (Tk./ha)	Variable cost (Tk./ha)	Gross margin (Tk./ha)	MBCR
				Control	Only inorganic fertilizer				
T <sub>1</sub>	2.92a	2.58a	82.74b	337	-	4,13,700	12,096	4,00,794	25.31
T <sub>2</sub>	3.03a	2.64a	84.06ab	344	1.60	4,20,300	10,277	4,10,023	30.68
T <sub>3</sub>	3.19a	2.79a	89.16ab	371	7.76	4,45,800	20,949	4,27,851	16.00
T <sub>4</sub>	3.11a	2.71a	86.78ab	358	4.88	4,33,900	9,443	4,27,457	35.03
T <sub>5</sub>	3.42a	2.93a	93.65a	394	13.19	4,68,250	17,872	4,50,378	19.90
T <sub>6</sub>	1.03b	0.68b	18.94c	-	-	94,700	0	94,700	-

Table 6. Effect of different nutrient package on the yield and return of Cauliflower

Treatment	Whole plant weight (kg)	Marketable weight (kg)	Card yield (t/ha)	% increase of card yield over		Gross return (Tk./ha)	Variable cost (Tk./ha)	Gross margin (Tk./ha)	MBCR
				Control	Only inorganic fertilizer				
T <sub>1</sub>	1.96a	1.50b	42.97c	238	-	2,57,820	10,771	2,47,049	16.42
T <sub>2</sub>	2.01a	1.58ab	44.36c	249	3.23	2,66,160	8,618	2,57,542	21.04
T <sub>3</sub>	2.14a	1.66ab	49.56ab	306	15.34	2,97,360	19,297	2,76,063	10.36
T <sub>4</sub>	2.06a	1.61ab	46.94bc	290	9.24	2,81,640	7,784	2,75,856	25.65
T <sub>5</sub>	2.17a	1.72a	53.77a	323	25.13	3,22,620	16,213	3,06,407	14.20
T <sub>6</sub>	0.56b	0.33c	12.70d	-	-	76,200	0	76,200	-

Price (Tk./kg): N = 13.04, P = 80.00, K= 32.00, S= 22.22, B= 352.94, Cowdung = 0.75, Poultry Manure= 1.00 CD slurry = 3.00, PM slurry = 4.00, cabbage= 5.00, cauliflower= 6.00



Picture 1. Wim van Nes, Biogas Practice Leader, SNV Advisors, IDCOL officers and BARI scientists visiting the bio-slurry experimental field

## On-Farm trials

The status of on-farm trials is given in Table 7.

**Table 7. Status of on-farm trials**

Planned			Executed		
No. of experiment.	No. of crops	No. of sites	No. of experiment.	No. of crops	No. of sites
01	09	25	017	07	20

### **Experiment: Effect of bio-slurry as a source of organic manure on performance of different crops**

On-farm trials were conducted at 20 sites with 7 crops (Table 8) during the rabi season of 2007-2008 to observe the performance of different crops grown in farmers field at varied environments as affected by bio-slurry. The experiment was laid out in RCB design with three compact replications and the same trial was conducted in three farmers' field at each site. Unit plot size was 8m x 5m. Five nutrient management options viz.-T<sub>1</sub>: Soil test based (STB) inorganic fertilizer for high yield goal, T<sub>2</sub>: Nutrient management following integrated plant nutrition system (IPNS) approach (with cowdung or poultry manure) for high yield goal, T<sub>3</sub>: Nutrient management following integrated plant nutrition system approach (with cowdung or poultry bio-slurry) for high yield, T<sub>4</sub>: Farmers dose and T<sub>5</sub>: Native fertility (no fertilizer used) were verified. The detailed fertilizer doses of treatments were determined based on crop varieties and soil test value of the different locations.

**Table 8. Different crops tested in different locations**

Crops	Location
Tomato	Pabna, Jessore and Rangpur
Cabbage	Gazipur, Tangail, Pabna and Jessore
Cauliflower	Gazipur, Tangail, Pabna,
Potato	Comilla, Rangpur and Joypurhat
Maize	Pabna and Rangpur
Boro rice	Pabna, Mymensingh, Tangail
Wheat	Faridpur and Rangpur

## Results and Discussions

### **Crop: Tomato**

The yield from cowdung bio-slurry treated plot was 17% and 8% higher than that of only inorganic fertilizer (T<sub>1</sub>) and IPNS with cowdung treatment, respectively. The yield from poultry bio-slurry treated plot was 40% and 4% higher than that of only inorganic fertilizer (T<sub>1</sub>) and IPNS with poultry manure treatment, respectively. Higher gross margin and MBCR were obtained from IPNS with bio-slurry (T<sub>3</sub>) due to higher gross returns and less variables cost.

**Table 9: Mean yield, cost and return analysis of Tomato as influenced by different nutrient management options during 2007- 08**

Treatment	Yield (t/ha)		Gross return(Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR (over native fertility)	
	Cowdung based	Poultry Based	CD	PB	Cowdung based	Poultry Based	Cowdung based	Poultry Based	Cowdung based	Poultry Based
T <sub>1</sub> : STB inorganic fertilizer for HYG	76.49	61.39	458910	368310	15846	15840	443064	352471	7.17	12.46
T <sub>2</sub> : IPNS with CD/PM	83.17	82.65	499020	495900	18349	17581	480672	478320	8.24	18.38
T <sub>3</sub> : IPNS with CD/PM slurry	89.77	85.67	538620	510020	16925	15931	521695	498090	11.35	21.53
T <sub>4</sub> : Farmers practice	71.70	40.41	430200	202460	19363	19363	410838	284328	4.20	6.68
T <sub>5</sub> : Native fertility	40.23	25.93	241350	155040	0	0	329510	155040	-	-

Price of input (Tk/kg) : Urea-6.50, TSP-32.00, MP-35.00, Gypsum-5.00, Zinc sulphate- 120.00, Boric acid-110.00, Cowdung-1.00 and cowdung slurry-1.00.

Price of Tomato (Tk/kg): Tk 6.00

CD = Cowdung based, PB = Poultry based 1 US dollar = Tk. 69

### Crop : Cabbage

Yield the treatment T<sub>3</sub> was about 22 % higher than that of the treatment T<sub>1</sub> and 6% than that of T<sub>2</sub>, respectively. Due to application of high amount of phosphorus and cowdung the variable cost was higher in farmers' dose (T<sub>4</sub>). Gross return, gross margin and MBCR were higher in the treatment where slurry was used.

**Table 10. Mean yield, cost and return analysis of cabbage (var. Autumn queen) as influenced by different nutrient management options during 2007-08**

Treatments	Yield (t/ha)	Gross return (Tk./ha)	Cost of fertilizer (Tk./ha)	Gross margin (Tk./ha)	MBCR over native fertility
T <sub>1</sub> : Inorganic fertilizer for HYG	72.05	288200	10178	278022	16.92
T <sub>2</sub> : IPNS with 5 t/ha CD manure	82.55	330200	11381	318819	18.82
T <sub>3</sub> : IPNS with 5 t/ha CD slurry	87.77	351080	11382	339698	20.65
T <sub>4</sub> : Farmers practice	54.17	216680	8579	208101	11.74
T <sub>5</sub> : Native fertility	29.00	116000	0	116000	-

LSD (0.05)

7.07

Price of input (Tk/kg): Urea 6.00, MP 35.00, TSP 40.00, Gypsum 7.00, Cowdung 1.00, Bio-slurry 1.00

Price of output (Tk/kg): 4.00



**Picture 2. Cabbage produced from without fertilizer (left) and with poultry bio-slurry (right)**

**Crop : Cauliflower**

Higher yield was obtained in the treatment T<sub>3</sub> where poultry bio-slurry was used. The yield of the treatment T<sub>3</sub> was 16, 9 and 14% higher than that of T<sub>1</sub>, T<sub>2</sub> and T<sub>4</sub>, respectively. Fertilizer cost ranges from Tk. 8604/ha to Tk. 8867/ha among the nutrient management packages. But it was higher in the farmers' dose due to application of large amount of phosphorus and higher amount of cowdung that resulted less MBCR. Gross margin as well as MBCR was higher in the treatment T<sub>3</sub> where poultry slurry was used.

**Table 11. Mean yield, cost and return analysis of cauliflower (var. Shiraziku ) as influenced by different nutrient management options during 2007-08**

Treatment	Yield (t/ha)	Gross return (Tk./ha)	Fertilizer cost (Tk./ha)	Gross margin (Tk./ha)	MBCR over native fertility
T <sub>1</sub> : Inorganic fertilizer for HYG	59.66ab	357960	8604	349356	31.14
T <sub>2</sub> : IPNS with 3 t/ha PM	63.32ab	379920	8932	370988	32.46
T <sub>3</sub> : IPNS with 3 t/ha PS	69.24a	415440	8867	406573	36.70
T <sub>4</sub> : Farmers practice	60.77b	364620	13609	351011	20.18
T <sub>5</sub> : Native fertility	15.00c	90000	0	90000	-

Price of input (Tk/kg) : Urea 6.00, MP 19.00, TSP 19.00, Gypsum 7.00, Cowdung 1.00, Bio-slurry 1.00,  
 Price of output (Tk./kg) : Cauliflower 6.00



**Picture 3. SNV Advisor, IDCOL officer & Head, OFRD visiting the Experimental plots at Gazipur**

**Crop : Potato**

**Location: FSRD site, Lahirirhat, Rangpur**

The yield of potato in cowdung slurry treated plot was 9% and poultry slurry treated plot was 26% higher than cowdung manure and poultry manure plots, respectively. Gross return, gross margin and MBCR were higher in the slurry treated plot (Table 12).

**Table 12: Mean yield, cost and return analysis of potato influenced by different nutrient management options at the FSRD site Laharirhat, Rangpur during 2007- 08**

Treatment	Tuber yield (t/ha)		Gross return (Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR over native fertility	
	Cowdung based	Poultry based	CDB	PB	CDB	PB	CDB	PB	CDB	PB
T <sub>1</sub> : Inorganic fertilizer for HYG	25.74b	14.13b	257400	141300	17626	16362	239774	124938	6.04	3.76
T <sub>2</sub> : IPNS for HYG with manure	26.64b	15.39b	266400	153900	20374	21235	246026	132665	5.33	3.49
T <sub>3</sub> : IPNS for HYG with slurry	29.10a	19.36a	291000	193600	21701	19906	269299	173694	6.35	5.96
T <sub>4</sub> : Farmers practice	28.89a	15.88b	288900	158800	33278	22024	255622	136776	4.08	3.59
T <sub>5</sub> : Native fertility	15.32c	7.97c	153200	79700	0	0	153200	79700	-	-

Price (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax = 65.00, Poultry manure (PM) = 1.50, Poultry slurry (PS) = 1.00, Potato = 10.00,

### Crop : Maize

#### Location : MLT site, Atghoria, Pabna

The crop performance with poultry slurry management appeared better over poultry manure probably because of readily available of different nutrients to the plants. Maximum water retention in poultry slurry probably has made the environment for easily uptake of nutrients by the crop plants (Table 13). Yield from slurry treatment was similar to that of inorganic fertilizer treated plot but significantly higher than that of poultry manure. MBCR was found in slurry treated plot due the less fertilizer cost.

**Table 13. Yield, cost and return analysis of maize (var. NK 40) influenced by different nutrient management options at the MLT site Atghoria, Pabna during 2007-08**

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR over native fertility
T <sub>1</sub> : Inorganic fertilizer for HYG	8.98a	116740	12619	104121	4.53
T <sub>2</sub> : IPNS with 3t/ha PM	8.32b	108160	12186	95974	3.99
T <sub>3</sub> : IPNS with 3t/ha PS	8.89a	115570	10208	105362	5.49
T <sub>4</sub> : Farmers practice	7.76c	100880	10189	90691	4.06
T <sub>5</sub> : Native fertility	4.58d	59540	0	59540	0

Price (TK/kg) : Urea = 6.00, TSP = 32.00, MP = 35.00, Gypsum = 8.00, Zinc sulphat = 120.00, Borax = 120.00.

Poultry manure = 1.50, Poultry slurry = 1.00, Maize grain = 13.00

#### Location: FSRD site, Laharirhat, Rangpur

The highest grain yield was obtained from the IPNS with slurry (5t/ha cowdung slurry or 3 t/ha poultry slurry) which was 9% higher than the cowdung or poultry manure (Table 14). Higher gross margin and MBCR were recorded from slurry treatment.

**Table 14. Yield, cost and return analysis of maize influenced by different nutrient management options at the FSRD site Laharirhat, Rangpur during 2007-08**

Treatment	Tuber yield (t/ha)		Gross return (Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR over native fertility	
	Cowdung based	Poultry based	CDB	PB	CDB	PB	CDB	PB	CDB	PB
T <sub>1</sub> : Inorganic fertilizer for HYG	4.57d	5.47c	69410	71110	11626	11633	57784	59477	2.78	3.71
T <sub>2</sub> : IPNS with manure	5.69b	6.19b	73970	80470	15143	14082	58827	66388	2.43	3.72
T <sub>3</sub> : IPNS with slurry	6.24a	6.76a	81120	87880	13451	13002	67669	74878	3.27	4.60
T <sub>4</sub> : Farmers practice	5.09c	5.58c	66170	72540	10954	10954	55216	61586	2.65	4.07
T <sub>5</sub> : Native fertility	3.85e	4.15d	37050	27950	0	0	37050	27950	0	0

Price (Tk/kg): Urea = 6.00, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax = 65.00,

Poultry manure (PM)= 1.50, Poultry slurry (PS)= 1.00 Maize = 13.00,

### Crop: Boro rice

A good response of organic fertilizer (cowdung or cowdung slurry) on the yield of Boro rice was found (Table 15). Higher yield was obtained from the application of IPNS with 5t/ha cowdung slurry but it was statistically similar with the application of IPNS with 5t/ha cowdung manure. Higher gross margin was obtained from the slurry treatment. Higher MBCR was obtained in the framers' practice due to less fertilizer cost.

**Table 15. Mean yield, cost and return analysis of Boro rice influenced by different nutrient management options during 2007-08**

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T <sub>1</sub> : Inorganic fertilizer for HYG	7.43	6.73	118180	16621	101559	3.72
T <sub>2</sub> : IPNS with 5 t/ha CD manure	7.74	6.98	123080	19206	103874	3.47
T <sub>3</sub> : IPNS with 5 t/ha CD slurry	8.19	7.26	130110	18419	111691	4.00
T <sub>4</sub> : Farmers practice	6.86	6.16	109060	8299	100761	6.35
T <sub>5</sub> : Native fertility	3.55	3.10	56350	0	56350	-

Price of input and output: Rice grain Tk. 15.00/kg, Rice straw Tk. 1.00/kg, Urea Tk. 6.15/kg, TSP Tk. 35.00/kg, MOP Tk. 32.00/kg, Gypsum Tk. 7.00/kg, Cowdung Tk. 1.00/kg and Cowdung slurry Tk. 1.00/kg

### Crop : Wheat

In cowdung based, the highest yield was found in the treatment where 5t/ha cowdung slurry was used (Table 16). Yield variation was not found from cowdung manure (T<sub>2</sub>) and the fully inorganic fertilizer (T<sub>2</sub>). In case of poultry based, higher but similar poultry slurry and poultry manure. Higher gross margin was obtained from IPNS with slurry.

**Table 16: Mean yield, cost and return analysis of wheat as influenced by different nutrient management options during 2007-08**

Treatment	Grain yield (t/ha)		Gross return (Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR	
	Cow dung based	Poultry Based	Cow dung based	Poultry Based	Cow dung based	Poultry Based	Cow dung based	Poultry Based	Cowdung based	Poultry Based
T <sub>1</sub> : Inorganic fertilizer for HYG	1.84b	1.65b	46000	41250	13611	12981	32389	28269	1.08	0.61
T <sub>2</sub> : IPNS for HYG with manure	1.64bc	1.71a	41000	42750	15873	14743	25127	28007	0.61	0.64
T <sub>3</sub> : IPNS for HYG with slurry	2.28a	1.74a	57000	43500	14499	13807	42501	29693	1.77	0.74
T <sub>4</sub> : Farmers practice	1.53c	1.40c	38250	35000	12056	8581	26194	26419	0.58	0.14
T <sub>5</sub> : Native fertility	1.25d	1.33d	31250	33250	0	0	31250	33250	0	0

Price (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00,  
Poultry manure (PM)= 1.50, Poultry slurry (PS)= 1.00 Wheat = 25.00,

**Appendix Table 1. Initial soil status of the experimental site**

Location	pH	O.M (%)	Total N (%)	K (m.eq./100g soil)	P	S	Zn	B
					ppm			
Mymensingh	5.22	1.14	0.11 (L)	0.048 (VL)	11.74 (L)	6.52 (VL)	2.41 (H)	
Gazipur	5.7	1.162	0.0614 (VL)	0.132 (L)	51.8 (VH)	12.2 (L)	3.04 (VH)	0.194 (L)
Pabna	7.7	2.13	0.12 (L)	0.25 (M)	9.00 (L)	13.00 (L)	0.50 (L)	0.25 (L)
Rangpur	6.03	1.25	0.06 (VL)	0.31 (M)	30.66 (VH)	33.30 (H)	0.82 (L)	0.52 (O)
Jessore	7.8	1.05	0.081(VL)	0.31 (O)	15 (M)	16 (M)	1.00 (M)	0.20 (L)
Tangail	5.9	2.60	0.137 (L)	0.14 (L)	12(M)	25(O)	4.3(VH)	0.57(O)
Bogra	4.93	0.599	0.060 (VL)	0.073(VL)	13.41(L)	7.146 (VL)	1.665(O)	-
Comilla	5.6	-	0.13 (L)	0.15 (L)	13.0 (M)	12.4 (L)	1.7 (L)	-
Faridpur	7.5	-	0.18 (M)	0.42 (H)	9.03 (L)	18.0 (M)	-	-

VL= Very low, L= Low, M= Medium, H= High, VH= Very High, O= Optimum

## Bio-slurry Extension

### Activity 1. Development of Extension Materials

The following extension materials have been developed and distributed to the target group members:

Title of extension material	Target group
A Manual on Management and Utilization of Bio-slurry in Agriculture	Agriculture Extension Workers
A Booklet Management and Utilization of Bio-slurry in Agriculture	Bio-slurry users
Demonstration Guidelines	Agriculture Extension Workers



## Activity 2. Training

IDCOL (Infrastructure Development Company Limited) with the support of SNV, Netherlands Development Organization, has been organizing different trainings under NDBMP (National Domestic Biogas and Manure Program) to capacitate personnel of stakeholders and farmers. These trainings are of different contents designed for various target groups.

Sl.	Type of Training	Target Group	Duration (days)	No. of persons trained (upto Oct.'08)
1.	ToT	Professional Trainers	2-5	150
2.	Supervisor	Engineers, Technicians	3	680
3.	Mason	Masons	4	990
4.	Users	Biogas plant owners	1	1800
5.	Bio-Slurry Utilization	Slurry extension personnel Plant owners	1-2 1	60 220
6.	Female Motivator	Females who can be good motivators	1	49
7.	Program Management	PO's Coordinators, Managers	2	55

## Activity 3. Demonstration

The demonstrations mentioned below are currently planned by NDBMP.

- Method Demonstrations on slurry compost preparation and preservation;
- Integrated Plant Nutrition System (IPNS) demonstrations;
- Home garden demonstration

Planning process

- NDBMP asked POs to submit seasonal demonstration plan in a standard format provided to them.
- The demonstration plans of POs are internally reviewed at NDBMP level.
- The plans are discussed in a seasonal workshop with the participation of NDBMP and POs and finalize the plan along budget.

Implementation and Reporting

A demonstration guidelines covering all details of implementation, reporting and budgetary aspects has been developed and followed.

NDBMP established 22 field demonstrations in Rabi season and 10 in Kharif season through selected POs. NDBMP do not receive the results yet.

## Bio-slurry Management and Utilization at Farm level

### Based upon NDBMP database

Seventy percent of the constructed plants have standard 2 bio-slurry pits.

Year	# of plants constructed	# of plants inspected	% of inspected plants having pits		
			0	1	2
2006	205		52	33	15
2007	2116		48	26	26
2008	2375		37	25	38
<b>Total</b>	<b>4696</b>		-	-	-

Most of the pits do not have proper shade and boundary.

### Based upon Survey on biogas user – 2007

Most of the users either have one (42%) or two (42%) pits for storing slurry. A few of them (16%) have no slurry pit at all. No standard sized slurry pit was found in the biogas user households. The users store bio-slurry in the slurry pits for on average of 53 days which range from 14 to 97 days. The variation of storing time depends on the type of use, practice of drying, and depth of slurry pit. The fish farmers use slurry within an interval of 14 days as fish feed. In other case, those who sell bio-manure used to dry in semi-dried condition spread on the ground. They transfer a small quantity of slurry from the primary pit to a secondary pit of shallow depth for a few days and then take it from the secondary pit to spread it on the ground for drying. Seventy five percent of the users dry slurry; 95% of them dry under the sun and the rest dry it in the shade. Most of the users (78%) do not add any other materials with slurry for decomposition. Only 22% add other organic materials with slurry in the slurry pit. From among these users who add other materials 90% add kitchen waste, waste of livestock fodder (straw), ash, water hyacinth and green compost manure (10%). Seventy four percent of the users use bio-manure (slurry) for field crop cultivation, home gardening (32%), fish culture (43%) and for selling (8%) purposes. Twenty eight percent of the users have not yet used bio-manure, as their manure is not yet dry. They are willing to use it for crop production in the coming season (Boro). From among the users, however, 57%, 31% and 11% use bio-manure respectively in dried, semi-dried and liquid form.

**Effectiveness of slurry:** All the slurry/bio-manure users feel that bio-manure increases soil fertility. They find the effectiveness of slurry as good (87%) and moderate (13%). Slurry use increases their crop yield. On the other hand, it decreases the use of inorganic fertilizer and thus saves on average Tk.13 per decimal per year. Ultimately, it increases the income of the household from crop and fish production.



Picture 5: Drying bio-slurry



Picture 6: Collection of Bio-slurry



**Picture 7: Compost carrying to field**



**Picture 8: Application of Bio-slurry to crop field**

### **Limitation**

In relation to organization and manpower

- NDBMP is implementing bio-slurry program with the participation of different partner organizations lacking specific skilled manpower. Bio-slurry extension is not their priority agenda.
- Modality of inclusion of proper agriculture organization is not well explained in the implementation plan.

In relation to technology

- Storage – Improper storage causes loss of quality and quantity of bio-slurry.
- Transportation – Transportation of liquid or semi liquid bio-slurry to the crop field specifically during wet season is difficult.
- Uses – Information regarding rate, time and method of application for specific soil and environment is not clear to farmers.

### **Lesson learned and Opportunity**

Lesson learned

- Further research on management and utilization of bio-slurry under varied conditions and environments is needed.
- Bio-slurry extension needs specific skilled manpower and interested organization
- Bio-slurry management aspects should be an integral part of budget and financing.

Opportunity

- Organizations experienced in performing agriculture research and extension activities are available to whom outsourcing of those activities is possible.
- High demand of bio-slurry as organic manure, organic fertilizers and feed for fish and animals.
- Use of bio-slurry as growth media of plant nursery and mushroom cultivation

## **Future plan**

- Continue backup research by outsourcing to national agricultural research institutes.
- Bio-slurry training and extension activities will be outsourced.
- Development of extension materials on utilization of bio-slurry as fish feed and nursery media.

## **Conclusion and Recommendation**

### Conclusion

Both anaerobically decomposed cowdung bio-slurry and poultry litter bio-slurry have higher nutrient value than aerobically decomposed cowdung and poultry manure. Cobalt, nickel, cadmium and arsenic concentration are minimal in bio-slurry. However lead toxicity was found in some poultry litter samples.

Both slurry of cowdung or poultry litter were found better than decomposed cowdung or poultry manure in terms of increasing crop yield and profit. Economically profitable production of tested crops were found in most locations from PM slurry @ 3 t/ha or CD slurry @ 5 t/ha with IPNS basis inorganic fertilizer application.

For effective bio-slurry extension programs it needs to select right partner organization and capacity building of their extension worker. Strengthening of bio-slurry users training is a primary tool for effective extension of bio-slurry. Establishing of farmers participatory demonstration and organizing field days at demonstration site is found an effective tool of bio-slurry extension. Storage, transportation and use of liquid bio-slurry are a great challenge for all concerned. For application of bio-slurry IPNS approach found most suitable considering nutrient and economic value of bio-slurry.

### Recommendation

- Continuation of backup research should be an integral part of the program
- Outsourcing of training and demonstration activities
- Organization having experience and interest in agricultural research & extension activities should be preferably involved.
- Selection of right public, NGOs or private organization experienced in agricultural activities
- Strengthening of linkage between public and private sector organizations
- Strengthening of capacity building of stakeholders and bio-slurry users
- Development of more training and promotional materials
- Use of mass media for dissemination of bio-slurry technology

## **6.3.2 Remarks from session chairman**

First of all chairman thanks all the presenters and participants for their nice presentations and cooperation extended to him for smoothly conducting the session. He summarized the views of participants on status and issues of bio-slurry activities of partner countries

of Asia and Africa region. He gave emphasis on further strengthening of bio-slurry extension activities particularly on proper collection, handling and improve management practices considering the local socio-economic condition. He also suggested to strengthening activities related to integrated use of bio-slurry and inorganic fertilizers for different crops and soils. He opined to strengthen bio-slurry users training in all country programs. He recommended to strengthen the applied research on various aspects of bio-slurry considering local needs and mentioned that these research results would serve as a good basis for efficient use of bio-slurry in crop and fish production and in turn would be a good material for training.

#### **6.4 Display and distribution of extension and promotion materials**

Different extension and promotion materials such as posters, leaflets, manuals, wall-hangings and pamphlets prepared for the promotion of bio-slurry were displayed. Copies of some printed materials related to biogas and bio-slurry were distributed to the participants.

#### **6.5 Field visit**

In the second and third days of the workshop participants visited biogas plants and bio-slurry activities (field demonstrations, home garden demonstrations, field day-farmers rally, application of bio-slurry in pond fish culture etc.) in five districts (Rajbari, Kustia, Natore, Bogra and Gazipur) and shared experiences with biogas plant owners and PO personnel. During field visit all participants were asked to take note on their individual observations and lesson learned from visited events and make comments and suggestions for future improvements. In the next day morning session (Recap of the experience of field visit), every participant presented a small written note expressing their observations, lesson learned and comments and suggestions for further improvement of bio-slurry activities. A summary of those observations, lesson learned and comments are given below:

##### **Observations**

- The visited biogas plants are in operation and all users were found happy (especially there was a glaze in the face of women) but gas is used only for cooking though there is high demand for lighting. Some of the non-biogas farmers attended in farmers rally showed their interest to construct biogas plant.
- Biogas plant owners are not poor farmers but they use bio-slurry in their own crop field and in fish pond and some farmers sold part of their bio-slurry to other farmers and it has high demand in the community.
- Farmers do not face any problem of bio-slurry transportation in this winter season
- Farmers usually dried bio-slurry before applied in crop field while semidried bio-slurry mixed with other fish feed or liquid bio-slurry directly applied in fish pond.
- Farmers expressed their opinion that cost for inorganic fertilizers and fish feed has been reduced due to application of bio-slurry.

- Farmers are not much aware about the rate of slurry to be used for different crops.
- Positive effect of bio-slurry on growth of rice was observed in demonstration plot.
- All field and home garden demonstration sites are easy accessible have signboards. These demonstrations attracted other farmers to use bio-slurry. Home garden demonstrations were found very attractive especially for more participation of woman.
- Bio-slurry could be successfully utilized in all the niches of the homestead as observed in home garden demonstrations conducted in Bogra and Gazipur.
- Farmers rally as organized at demonstration site in Kustia is a good tool to show the effect of bio-slurry on crop performance and dissemination of biogas and bio-slurry technology.
- Activities with bio-slurry are new to farmers and they showed their interest.
- Some farmers used high rate of bio-slurry in rice field and the crop lodged.
- Varied amount of bio-slurry and its various methods of application in different fish ponds were observed.
- The size and shape of bio-slurry pits and pit shade found varied.
- Farmers are less aware about the micro-credit facilities available for construction of biogas plant.

### **Lesson learned**

- Greetings and welcome reception from each households.
- Co-operation and linkage between POs and BARI at field level was found appreciable.
- Already a good network has been established among stakeholders for bio-slurry utilization.
- Application of the approach of integrated use of bio-slurry and inorganic fertilizer
- Application of bio-slurry in model home garden and mixture of bio-slurry with other fish feed.

### **Comments and Suggestions**

- It is important to incorporate a well structured bio-slurry unit/component in all country programs.
- It was observed that all biogas plant owners are relatively rich. How can we make biogas plant available to the poorer section of the society?
- Many farmers are not aware of the improve management and utilization of bio-slurry. It is needed to establish more number of demonstrations and organize farmers rally at demonstration sites.
- It is needed to organize training programs on bio-slurry management and utilization for biogas plant owners immediately after construction of biogas plant.
- Standardization of pit shade is necessary.
- Further strengthening of adaptive research on quality, management and utilization of bio-slurry and linkage between research and extension is needed.

- Standardization of amount and application of bio-slurry in fish culture need to be developed.
- Outsourcing of bio-slurry activities to BARI is highly appreciated. BARI home garden model can be replicated to other countries. The laboratory of Soil Science Division of BARI is well equipped and modern.
- IPNS approach of using organic and inorganic fertilizer applied in field demonstrations can be replicated in all participating countries of biogas program.
- Initiate program for promoting bio-slurry composting and on multipurpose and commercial utilization of bio-slurry for long-term sustainability.
- The field visit was well organized but the locations were long distant from each other so lot of time was spent in traveling. Time to visit each household or event was short to interact more with farmers. Field visit should be either for 3 days or limited within short distant locations.

## 6.6 Technical Session II

### 6.6.1 Group Exercise

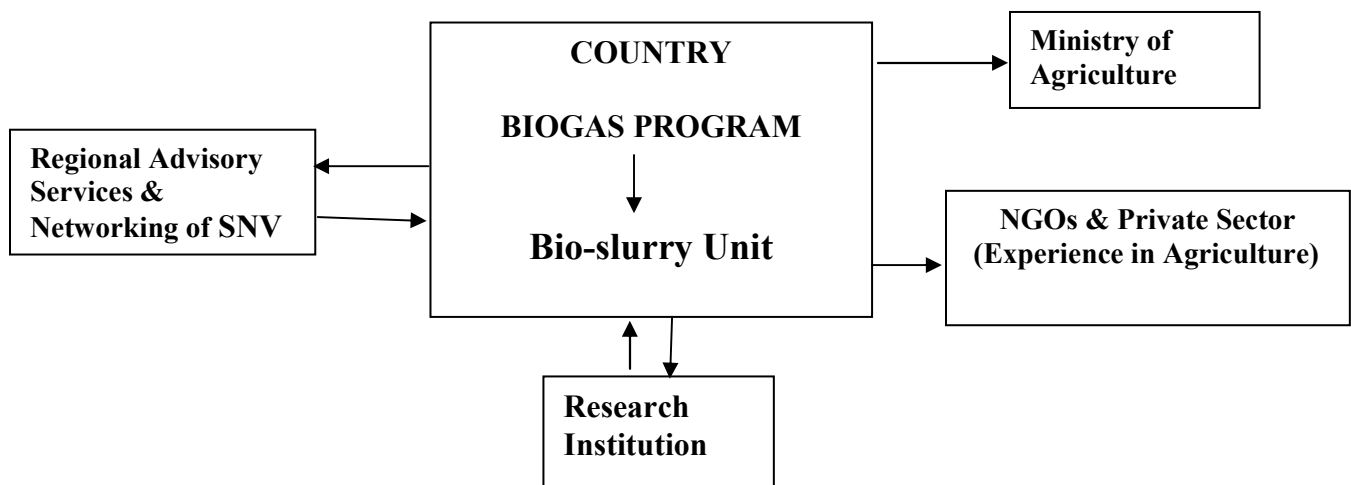
The next agenda after recap of the experience of field trip was the group exercise. The exercise was divided into the following two discussion sessions:

#### **Group discussion on further issues related to organizational management and research, training and extension of bio-slurry**

Mr. Sundar Bajgain of SNV, Bangladesh was act as chairperson of the session. At the beginning of the session Dr. Fokhrul Islam gave a brief on the topic and invited individual participants to put forward her/his opinions on the issues. The opinions are compiled and given below:

#### **Organizational issues**

A definite organizational structure and appropriate manpower is extremely needed for success of the program. A structure is proposed below:



Each of the country programs should have a Bio-slurry unit/component headed by a national Bio-slurry Extension Officer having background in agronomy. Bio-slurry unit will establish a formal implementation mechanism or linkage with agricultural extension agencies (public, NGOs & private) and agricultural research and training institutes.

SNV should establish a regional network and providing advisory services to the country programs.

### **Issues on research, training and extension of bio-slurry**

There should be undertaken further research on various technical aspects of manure management and continuation of research to develop sustainable local systems in each country. For the interest and capacity of our program each country program can establish better link with local research institutes and universities. We may establish need based research on cattle and poultry manure in Bangladesh and possibly in Nepal and pig manure in Vietnam.

We should initiate a training course on manure management practices and use of manure for maintaining soil fertility and crop production. A TOT course can be organized for our program implementing partners of Asia and Africa.

Each country program should strengthen its training for biogas plant owners or bio-slurry users immediately after completion of biogas plant.

Identify most suitable extension tools and promote its application. Extension methods and vehicles identified in Nepal meeting in 2007 should be continued and evaluate its effectiveness at local context and share best practices through network and study visit.

### **Group discussion on future action plan**

Dr. Fokhrul Islam of SNV, Bangladesh was act as chairperson of the session. Each country representative presented their future action plan, discussed by the participants and incorporated the accepted comments and suggestions. Each country action plan is given below:

#### **Bangladesh 2009**

<b>Issues</b>	<b>Activity</b>	<b>Indicators</b>
Strengthen Bio-slurry unit	NDBMP may employ one fulltime bio-slurry extension officer having background in agronomy. NDBMP will employ 1-2 quality inspector having diploma in agriculture.	One bio-slurry extension officer and 2 quality inspectors will be apponted.
	Development of seasonal and annual work plan	Annual work plan and 3 seasonal plans



Networking and outsourcing	Establishment of information exchange network at NDBMP.  Bio-slurry research and extension will be outsourced to suitable organizations experience in agriculture research and extension.	Organization of meetings, seminar and workshops with bio slurry stakeholders Signing of MoU with suitable organization(s).
Standardization	Develop standard for bio-slurry pit shade	Pit shade standard
Capacity building at different levels	Organize Training of Trainer (ToT) for BARI officers and PO supervisors	All concern officers of OFRD of BARI and PO coordinators will get training on bio-slurry management and its application.
	BARI and PO will organize training on bio-slurry for concern scientific field staffs and supervisors, respectively.	About 150 scientific assistants and 60 supervisors will receive training
	BARI will organize training on bio-slurry for co-operator farmers of on-farm trials and demonstrations.	About 600 cooperator farmers will receive training
	Training on bio-slurry for biogas plant owners or bio-slurry users.	At least 1500 biogas plant owners will receive the training. At least 40% of trained biogas farmers will adapt proper collection, preservation and use of bio-slurry.
	Aware masons to promote bio-slurry collection and preservation.	All new masons will get information about bio-slurry collection and preservation.
	An annual workshop on outcome of research and extension on aspects of bio-slurry will be organized with the participation of relevant stakeholders and NGOs.	An annual workshop will be organized.
Bio-slurry extension	Develop and implement seasonal demonstration and farmers exchange visit plan  Development of strategy for application of IPNS approach	Total 360 field demonstrations and 20 home garden demonstrations will be established. 10 field day programs will be organized. IPNS approach will be followed in bio-slurry research, training and extension
Monitoring of field activities	Regular monitoring will be done by the staffs of NDBMP and SNV Advisors. Annual Biogas users survey	A monitoring plan will be developed.  Annual biogas users' survey will be outsourced.
Bio-slurry research	Bio-slurry research will be outsourced.	MoU will be signed between NDBMP and suitable research institute(s)

## Cambodia 2009

Issues	Activity	Indicators
Strengthen Bio-slurry unit	NBP will employ one fulltime bio-slurry coordinator having agronomy or extension background for each province. S/he will work directly under PBPO director and in close	All targeted provinces will have one bio-slurry coordinator

	cooperation with PBPO coordinator.	
	Increase the number of bio-slurry extension workers at all provinces and district level.	Bio-slurry extension workers will be assigned at district level
	The bio-slurry extension workers will be provided incentive by activities based.	-
	Model farmers will be selected at commune level where 15-20 digester plants had been constructed. The district bio-slurry promoter will follow up the model farmers.	One model farmer will be selected from every 15-20 bio-digester owners. Total 300 model farmers will be selected in 2009.
	Development of seasonal and annual work plan	-
Program ownership and networking with specialized Institutions	NBP will convince the department of agriculture and the ministry of agriculture for hosting the bio-slurry activities of NBP.  Establishment of information exchange networks at national level in NBP or in DoA	The DoA will assign their staffs to implement bio-slurry extension activities.  Organization of annual meeting with bio slurry stakeholders
Standardization	NBP will develop standards for bio-slurry collection, management and application	A guideline of standards for bio-slurry collection, management and application will be printed for distributing to concern personnel.
Capacity building at different levels	Organize Training of Trainer (ToT) for bio-slurry coordinators and extension officers of DoA.	All bio-slurry coordinator and extension officers of DoA will get training on slurry management and its application.
	PBPO will organize training on bio-slurry for bio-slurry extension workers of PDoA.	All bio-slurry extension workers will receive training
	Aware PBPO supervisor and mason to promote bio-slurry management issues at the beginning and after sale service.	All biogas supervisors and mason will get initial information about bio-slurry collection and its proper management.
	Training on bio-slurry for biogas farmers.	- At least 3000 biogas farmers will access the training. - At least 70% of biogas farmers know the proper management of bio-slurry and its application. - At least 40% of biogas farmers will adapt and have compost hut with roof.
	The National and provincial workshop on aspects of bio-slurry will be organized with the participation of relevant stakeholders and NGOs.	A national workshop will be organized. Provincial workshop will be organized one in each province.
Bio-slurry extension	Develop and implement seasonal demonstration and farmers exchange visit plan  Development of strategy for application of IPNS approach	- 300 field visits for biogas farmers will be organized.
Monitoring of field activities	Regular monitoring will be done by the staffs of NBP and PBPO. Annual Biogas users survey	A monitoring plan will be developed.  Annual biogas users' survey will be outsourced.
Bio-slurry research and	Bio-slurry research will be outsourced.	MoU will be signed between NBP and

development	Support postgraduate students to do need based research on bio-slurry	suitable research institute and universities Four students will be supported.
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### Lao PDR 2009

<b>Issues</b>	<b>Activity</b>	<b>How</b>	<b>When</b>	<b>Who responsible</b>
Establish Bio-slurry Unit within the biogas program.	Recruit a fulltime Bio-Slurry Extension Officer having background in agronomy.	Developing detail Job description, advertising and interviewing.	Early January 2009	Project Manager (PM), BPP
	Establish formal agreement with sustainable Bio-slurry Extension Organization.	Discussion, consultation and making MoU	February 2009	Project Manager, BPP
Networking	Establishment of information exchange network at national level in BPP	Establishing formal and informal linkages with organizations working in agriculture	Within June 2009	Project Manager, BPP
Standardization of pit, shade and Bio-slurry application	Develop a guideline covering standards for bio-slurry pit, pit shade, bio-slurry collection, preservation and utilization.	Hiring Dr. Fokhrul Islam, Bio-Manure Management Advisor, SNV Bangladesh to develop that guideline in English. Translate the English version to local language	January 2009	Bio-slurry Extension Officer of BPP and Dr. Fokhrul Islam
Capacity building and Ownership	Development of bio-slurry extension materials (training manual, booklet and leaflet etc.)	Hiring Dr. Fokhrul Islam, Bio-Manure Management Advisor, SNV Bangladesh <ul style="list-style-type: none"> <li>• To develop a training manual for use in ToT course.</li> <li>• Assist in developing a booklet for use of bio-slurry extension workers of BPP</li> <li>• Assist in developing a leaflet for bio-slurry users</li> </ul>	January 2009	Bio-slurry Extension Officer of BPP and Dr. Fokhrul Islam
	Develop a training plan for 2009	Using training manual for ToT course	March 2009	Bio-slurry Extension Officer

	Organize a ToT course for extension officers of the department of agriculture			
	Organize a training course for bio-slurry extension workers		April 2009	Bio-slurry Extension Officer
	Organize a study tour to Thailand	Selection of interested farmers who willing to enter in business of organic farming	May/June 2009	Bio-slurry Extension Officer and Farmers
	Develop a business plan on how to package and sell bio-slurry.	Appropriate training courses will be sought for farmers.	July/August 2009	Bio-slurry Extension Officer
Bio-slurry extension	Establish on-farm trials and demonstrations with organic farmers.	Select potential farmers who are currently using bio-slurry and farmers who are involving in PROFIL Project.	February-April 2009	Bio-slurry Extension Officer and PM, BPP.

## Rawanda

Issues	Activity plan		
	2009	2010	2011
Establishment of Bio-slurry unit in biogas program	Establishment of Bio slurry unit at NDBP  Recruitment of a Bio slurry Officer for the National Program	Reinforcement of the bio-slurry unit at decentralised level	-
Networking with specialized Institutions and authorities	Identification and selection of suitable partner organizations  Signing of MoU with selected partner organizations  Organization of a national workshop with bio slurry stakeholders	Establishment of information exchange networks at national level  Organization of annual meeting with bio slurry stakeholders	Organization of annual meeting with bio slurry stakeholders
Standardization and monitoring of installations and practices	Pit size and boundary will be standardized according to local conditions  Size, shape and materials for pit	Review and application of standards  Continuous monitoring at farm level	Review and application of standards  Continuous monitoring at farm level

	shade will be standardised		
Capacity building at different levels	<p>Development of a bio slurry training manual for ToT course</p> <p>Development of extension materials for use of extension personnel and farmers</p> <p>Development of annual bio slurry training plan</p> <p>Organization of ToT courses for extension officers</p> <p>Outsourcing of training and demonstration activities</p>	<p>Development of annual bio slurry training plan</p> <p>Monitoring of training to be offered by training centres</p>	<p>Development of annual bio slurry training plan</p> <p>Monitoring of training to be offered by training centres</p>
Bio-slurry extension	<p>Development of seasonal demonstration and farmers exchange visit plan</p> <p>Development of strategy for application of IPNS approach</p>	Implementation of demonstration plan	Implementation of demonstration plan
Research and development	<p>Finalization of ToR for research related to bio slurry quality, management and utilization</p> <p>Outsourcing of bio-slurry research to suitable organization</p> <p>Introducing bio slurry based Integrated Plant Nutrient System (IPNS)</p> <p>Publications of bio-slurry related documents and reports</p>	<p>Organization of a National workshop on bio-slurry</p> <p>Facilitate for preparation of documents related to bio-slurry research</p> <p>Application of Integrated Plant Nutrient System (IPNS) approach</p>	Application of Integrated Plant Nutrient System (IPNS) approach

### Future action plan of Vietnam

- Present research and demonstration activities will be continued.
- More promotional and education document will be developed.
- Stakeholder meetings will be organized
- An advisory committee can be set up for strengthening research & demonstration

## **Future action plan of Nepal**

To maximize the bio-slurry utilization in the country the following activity will be carryout in future.

- Updating the existing bio-slurry extension materials.
- Continue the applied research at farm level.
- Carry out demonstration activities in some potential district with the coordination of District Agricultural Development Office.
- Training to Biogas Company personnel and biogas users on bio-slurry management.
- Continue to bonus scheme to Biogas Company on the proper management of bio-slurry.

## **6.7 Recapitulation of the study tour events**

The following views and observations were expressed by the participants:

- A discussion and decision on established of bio-slurry unit within the biogas program in each participating countries.
- Interactions between participants from different countries are beneficial. There is lots of learning which could be applied at the work place. The application of the learning needs to be targeted towards the end-users.
- The issues discussed in relation to bio-slurry management and utilization at the farm level has to be given importance.
- The IPNS approach should be followed in case of research, extension and application of bio-slurry.
- A coordinated effort is needed among the sector institutions to effectively generate, verify and convey the right message to the end-users.
- The experience of field visit realize that we have to do more on awareness building among farmers regarding improve management practices of bio-slurry and integrated use of slurry and inorganic fertilizers.
- Discussion on strengthening of further development of new extension materials, effective training, field and home garden demonstrations, field day-farmers rally etc.

## **6.8 Evaluation of the study tour**

Dr. Fokhrul Islam, coordinator of the program facilitated the session on evaluation of the study tour from participants' perspectives. Recapitulating the three main activities during the tour – (i) Information exchange between participants through presentations and discussions on country papers as well as informal exchange during breaks and evening programs (ii) Field visit and (iii) Group exercise and logistic support provided by the organizer. Each participant has given her/his comments.

All the participants (100%) agreed that overall objective of the study tour has been achieved. But the time for discussion was short and not enough. Pre-structured country reports, presentations and discussions were educative and lovely. Well organized excellent logistic services were provided. During field visit many things related to bio-slurry extension and utilization were observed and learned. However, the following remarks on field visit were made by some of the participants:

- The field visit was well organized but the locations were long distant from each other so lot of time was spent in traveling.
- Time to visit each household or event was short to interact more with farmers.
- Field visit should be either for 3 days or limited within short distant locations.

## **6.9 Follow-up plan**

- Bio-slurry workshop and study tour program should be institutionalized and arranged once in a year to cover the review of last year activities and workplan for the next year and observe and learn experience about the management of bio-slurry and its effect on agricultural production.
- The next international bio-slurry workshop and study tour is proposed to be organized in Cambodia.
- Well structured regional bio-slurry network should be established.
- All the participants agreed to share knowledge and information on bio-slurry via emails and other suitable means.

## **6.10 Informal Closing**

Dr. Fokhrul Islam gave a summary of the presentations, field visits and group discussions. Chairperson Mr. Sundar P Bajgain distributed crest and certificate of participation to all participants and gave his closing remarks as follows:

- Knowledge and information exchanged during the workshop would be translated in the workplace for the betterment of the end users.
- Such kind of study tour as a learning and sharing event should be continued in future.
- More attention should be given for research, training and extension on bio-slurry.
- More linkage is needed with universities and research organizations and other stakeholders of agriculture sector
- Things should be done in a very systematic ways

The workshop came to an end with vote of thanks from Dr. Fokhrul Islam to the CEO and Director (Legal) of IDCOL, Mr. Wim van Nes, Biogas Practice Team Leader, Ms. Megan Ritchie, Country Director, SNV Bangladesh, Mr. Rajendra Shakya, Regional Head of Administrator for their guidance and cooperation, team members of NDBMP and all the participants for their active contributions during the entire period of such a wonderful learning and sharing event-the study tour. With the permission of the chairperson he closed the workshop with an invitation to all the participants to join the dinner.

## **7. CONCLUSION**

The international study tour has been instrumental in providing an organized platform for those working in domestic biogas sector in different countries to share best practices on the use of bio-slurry at the micro level and to identify potential stimulus as well as barriers to further optimize the use of bio-slurry. The study tour findings clearly indicated that lot of efforts has been paid from program personnel to motivate potential farmers to use bio-slurry effectively and sustainable efficient extension services will be instrumental in this process. In all new programs bio-slurry component should be initiated at the time of biogas activities started. In countries with matured growth and established biogas programs, the focus should be on enhancing the quality of extension services being delivered while in countries where the technology is relatively new quality as well as quantity of extension activities should be taken care and slurry application should be one of the topics for promotion. Therefore, there is need to contextualize the extension activities based upon the level of understanding of the people, availability of extension network and media, accessibility of information etc. The evaluation results clearly indicated that the study tour has been successful in achieving its objectives. International bio-slurry workshop and study tour program should be institutionalized and arranged once in a year.



# ANNEXES

**Annex-1: Workshop and study tour schedule**  
**Venue: Washington Hotel, Dhaka, Bangladesh**

<b>Monday, 10 November 2008</b>		
<b>Inaugural Session      Chairperson: Mr. S.M. Formanul Islam</b>		
09.00	Guests and Participants take their seats	All
09.00-09.10	Personal introduction	All
09.10-09.25	Welcome and Overview of prospect, potentialities and challenges of use of bio-slurry in agriculture	Dr. M. Fokhrul Islam Advisor, SNV Bangladesh
09.25-09.35	Address by	Mr. Sundar Bajgain Senior Advisor, SNV Bangladesh
09.35-09.45	Address by Special Guest	Mr. Dewan Md. Emtazul Islam Director (Field Service Wing), DAE
09.45-09.55	Address by Special Guest	Mr. Abdul Mazid Biswas Director General, DAE
09.55-10.10	Address by the Chief Guest	Mr. M. Harun-ur-Rashid Executive Chairman, BARC
10.10-10.25	Address by Chairperson	Mr. S.M. Formanul Islam Director (Legal) & Company Secretary, IDCOL
10.25-10.30	Vote of Thanks	Mr. Nazmul Haque Faisal Senior Manager, NDBMP
10.30-11.00	Refreshment	
<b>Technical Session : Chairperson – Professor Dr. Jahiruddin</b>		
	Presentation of Country Report	
11.00-11.30	Vietnam	Ms. Le Thi Xuan Thu
11.30-12.00	LAO PDR	Mr. Thongchanh Santhasith
12.00-12.30	Rwanda	Mr. Uwizeye Jean Claude
12.30-14.00	Lunch	
14.00-14.30	Nepal	Mr. Ramesh Nath Regmi
14.30-15.00	Ethiopia	Mr. Dereje Gebremichael
15.00-15.30	Cambodia	Mr. Kong Kea
15.30-16.00	Tea/Coffee break	
16.00-16.30	Bangladesh	Dr. M. Fokhrul Islam Mr. Ranjit Sen Mr. Wahidur Rahman
16.30-17.00	General Discussion	
17.00-17.30	Comments from Chairperson	
17.30	Day close	
<b>Tuesday, 11 November 2008</b>		
07.15 -	Field trip	
<b>Wednesday, 12 November 2008</b>		
08.00 -	Field trip	
<b>Thursday, 13 November 2008</b>		
08.30-09.00	Recap of the experience of Field Trip	
09.00-09.10	Introduction to the group discussion on further issues related to research, training and extension of bio-slurry	Dr. M. Fokhrul Islam
09.10-11.00	Group discussion	
11.00-11.30	Tea/Coffee break	
11.30-12.00	Presentation of and plenary discussion on the results of the group discussion	Chairperson: Mr. Sundar Bajgain
12.00-12.10	Introduction to the group discussion on action plan with reference to the plan taken in Nepal study tour in 2007	Dr. M. Fokhrul Islam
12.10-13.00	Group discussion and preparation of country action plan	
13.00-14.00	Lunch	
14.00-15.00	Group discussion (Continue)	
15.00-15.30	Presentation of country action plan and discussion	Chairperson: Dr. M. Fokhrul Islam
15.30-16.00	Tea/Coffee break	
16.00-16.30	Summary and closure	Dr. M. Fokhrul Islam Mr. Sundar Bajgain
19.00-21.00	Farewell dinner	

## Annex-2: List of participants

Name	E-mail	Organisation/function
<b><i>From Bangladesh:</i></b>		
Mr. Sundar P Bajgain	sbajgain@snnworld.org	SNV/Bangladesh, Senior Biogas Advisor
Dr. M.Fokhrul Islam	fislam@snnworld.org	SNV/Bangladesh, Bio-Manure Management Advisor
Mr. Nazmul Haque Faisal	faisal@idcol.org	IDCOL, National Domestic Biogas and Manure Programme, Senior Program Manager
Mr. Wahidur Rahman	wahid@idcol.org	IDCOL, National Domestic Biogas and Manure Programme, Investment Officer (Technical)
Mr. Ranjit Sen	senbari@yahoo.com	Bangladesh Agricultural Research Institute (BARI), Scientific Officer
Mr. Kamrul Hassan	kamrulnk@yahoo.com	Bangladesh Agricultural Research Institute (BARI), Scientific Officer
<b><i>From Cambodia:</i></b>		
Mr. Kong Kea	kongkea@nbp.org.kh	National Bio-digester Program (NBP), Bio-slurry Extension Officer
Mr. Khin Daravuth	<a href="mailto:khindaravuth@online.com.kh">khindaravuth@online.com.kh</a>	CEDAC, Field Coordinator
<b><i>From Ethiopia:</i></b>		
Mr. Dereje Gebremichael	sustainet@yahoo.co.uk	ISD, Program Coordinator
<b><i>From Lao PDR:</i></b>		
Mr. Nivath Phanaphet	nivath@biogaslao.org	Project Director, Biogas Pilot Program, LAO-PDR
Mr. Thongchanh Santhasith	thongchanh@biogaslao.org	Program Manager, Biogas Pilot Program, LAO-PDR
<b><i>From Nepal:</i></b>		
Mr. Ramesh N. Regmi	ramesh_regmi57@yahoo.com	BSP-Nepal, Slurry Coordinator
Mr. Bibhuti Bista	nbpg@nbpg.wlink.com.np	NBPA, Program Officer
<b><i>From Rwanda:</i></b>		
Mr. Jean Claude Uwizeye	uwizeyejc@yahoo.com	MinInfra/NDBP, Sr. Biogas Technician
Mr. Valens Mwumvaneza	mwumvanezavalens@gmail.com	ISAE, Researcher
<b><i>From Vietnam:</i></b>		
Mr. Nguyen Khac Tich	khactic@vnn.vn	CISDOMA, Vice Director
Ms. Le Thi Xuan Thu	thultx@biogas.org.vn	MARD/Biogas Project Division, Biogas Agricultural Engineer